Operators' Instructions

Type "G" Engines

Models GRS—GR—GH—GM

Built in 4–6–8 Cylinder Sizes

STERLING ENGINE COMPANY

BUFFALO, N. Y.

5–1–22

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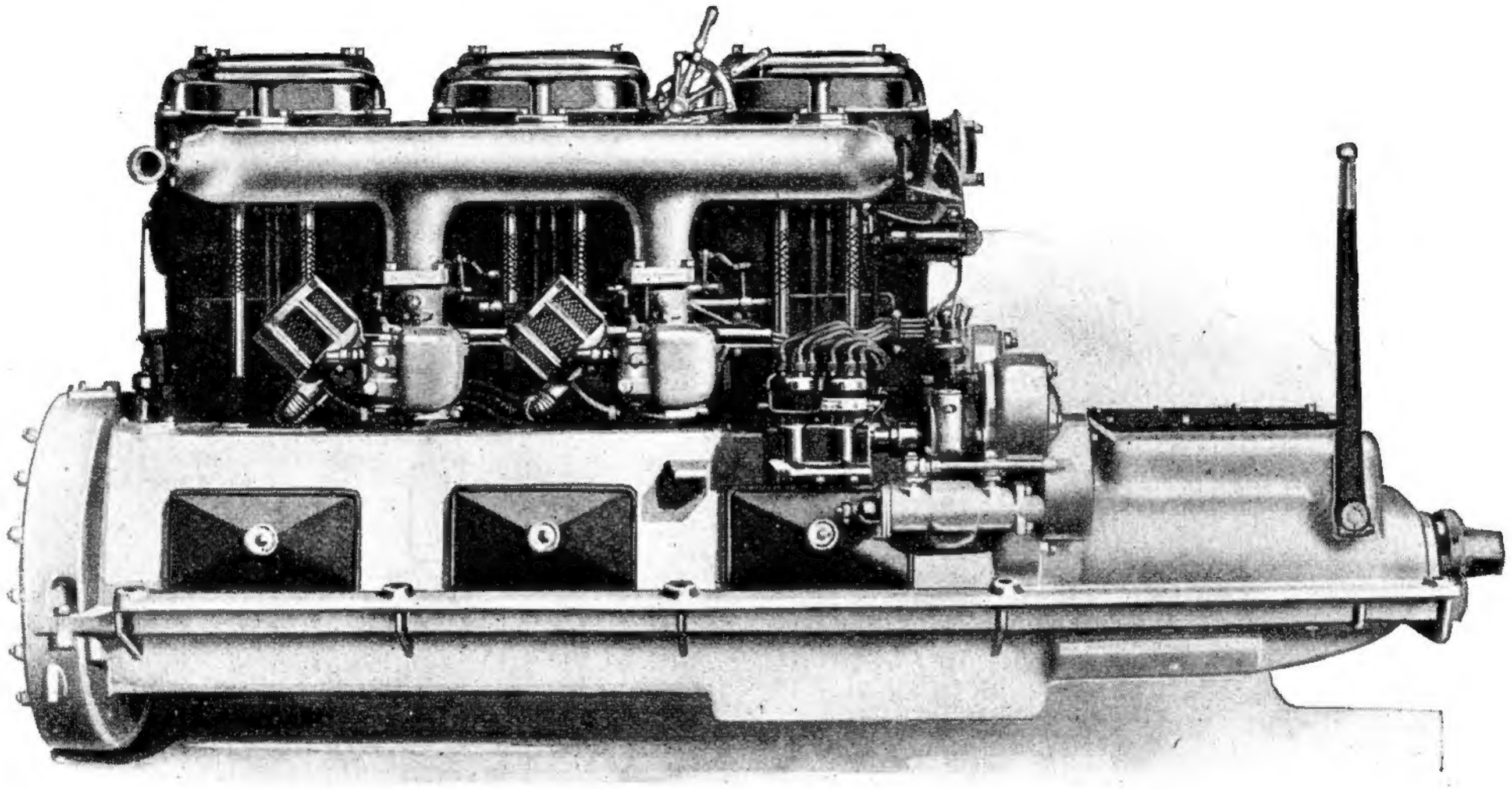

Inlet Side Model GRS Six Cylinder STERLING (The Dolphin Special)
Bore 5¾", Stroke 6¾". Rated 275 H. P. at 1950 R. P. M.

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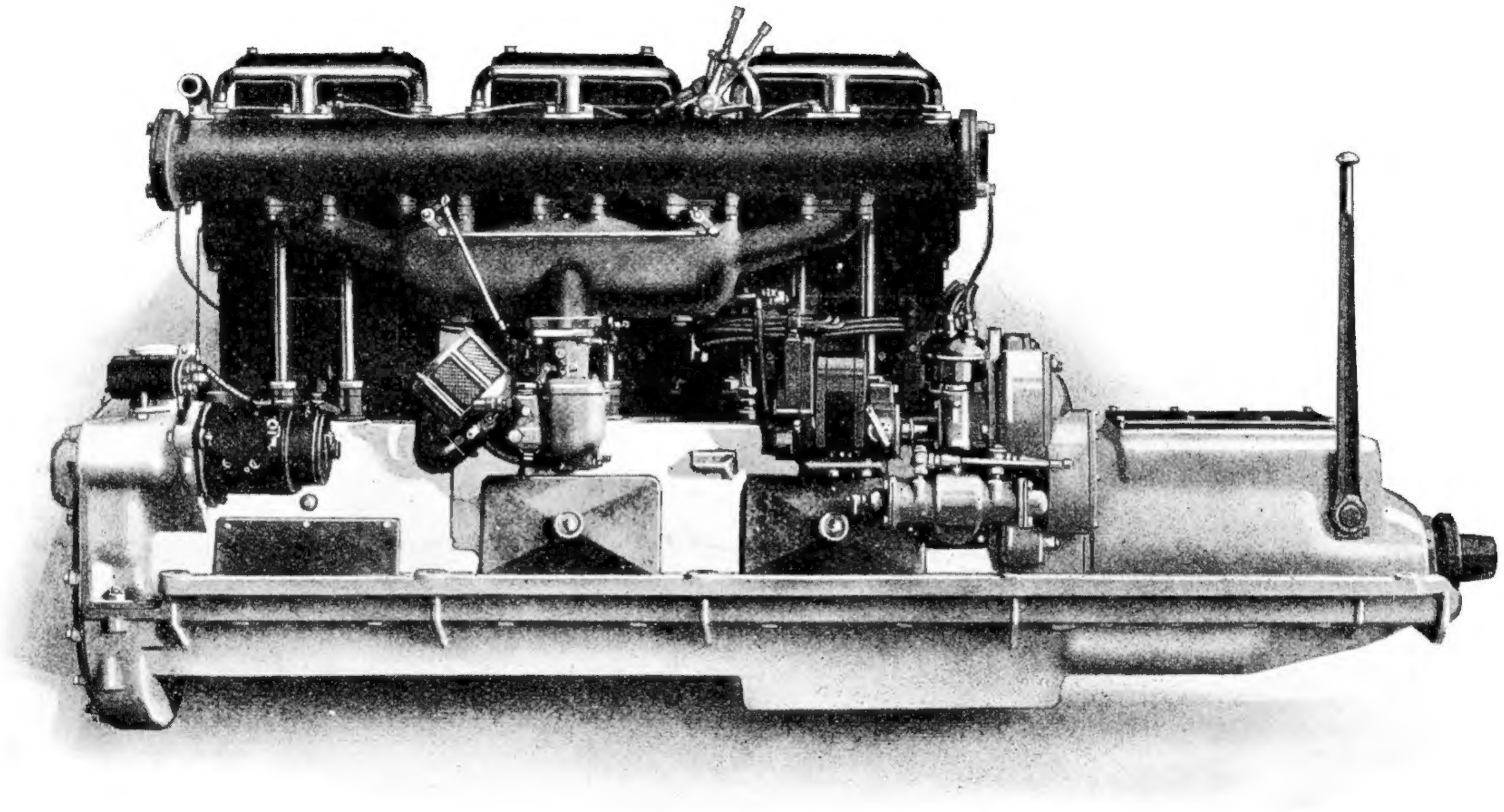


Inlet and Exhaust Side Model GH and GM Six Cylinder STERLING
(The Trident Model)

TO THE OWNERS AND OPERATORS OF MODEL "G" STERLING ENGINES

The information contained in this instruction book is furnished that an understanding of the construction and function of the engine and accessories will result in the operation of the engines at the maximum efficiency. With proper care the engine will perform in a highly satisfactory manner, while failure to heed the advice will result in loss of service to the owner, and this loss is also ours.

STERLING engines are built to meet the special requirements of marine service and with modifications in construction to best adapt it for the different classes of boats. The material and workmanship are intended to meet all the service demands of normal use. Accessories are selected of the highest quality obtainable and are guaranteed by their respective manufacturers. We are entirely dependent on the engine operators to give these parts careful consideration, so that satisfactory service is obtained. The responsibility is therefore so largely up to the operator that we can only request that he do his utmost in giving the engine the care it requires.

The installation is of equal importance to the care of the engine and boat builders as well, as operators are urged to mount the engine and fit the connections in a careful and workmanlike manner. The final results are seriously affected if controls, piping, wiring, shafting and foundations are not installed so as to operate as intended.

In the endeavor to obtain the best possible performance from the engines, it is necessary to build the various types with variations in construction and to make changes in design from time to time. Some descriptions of parts and accessories will therefore not apply to all engines. The instructions, however, cover the different models of engines as completely as possible. Additional detail information regarding accessories can be obtained from the instructions issued by the manufacturers of these instruments.

When ordering parts or writing regarding an engine, state **model** and **engine number,** which will be found on name plate.

INSTALLATION DIAGRAM
MODEL-G

Sterling ENGINE COMPANY BUFFALO, N.Y. U.S.A.

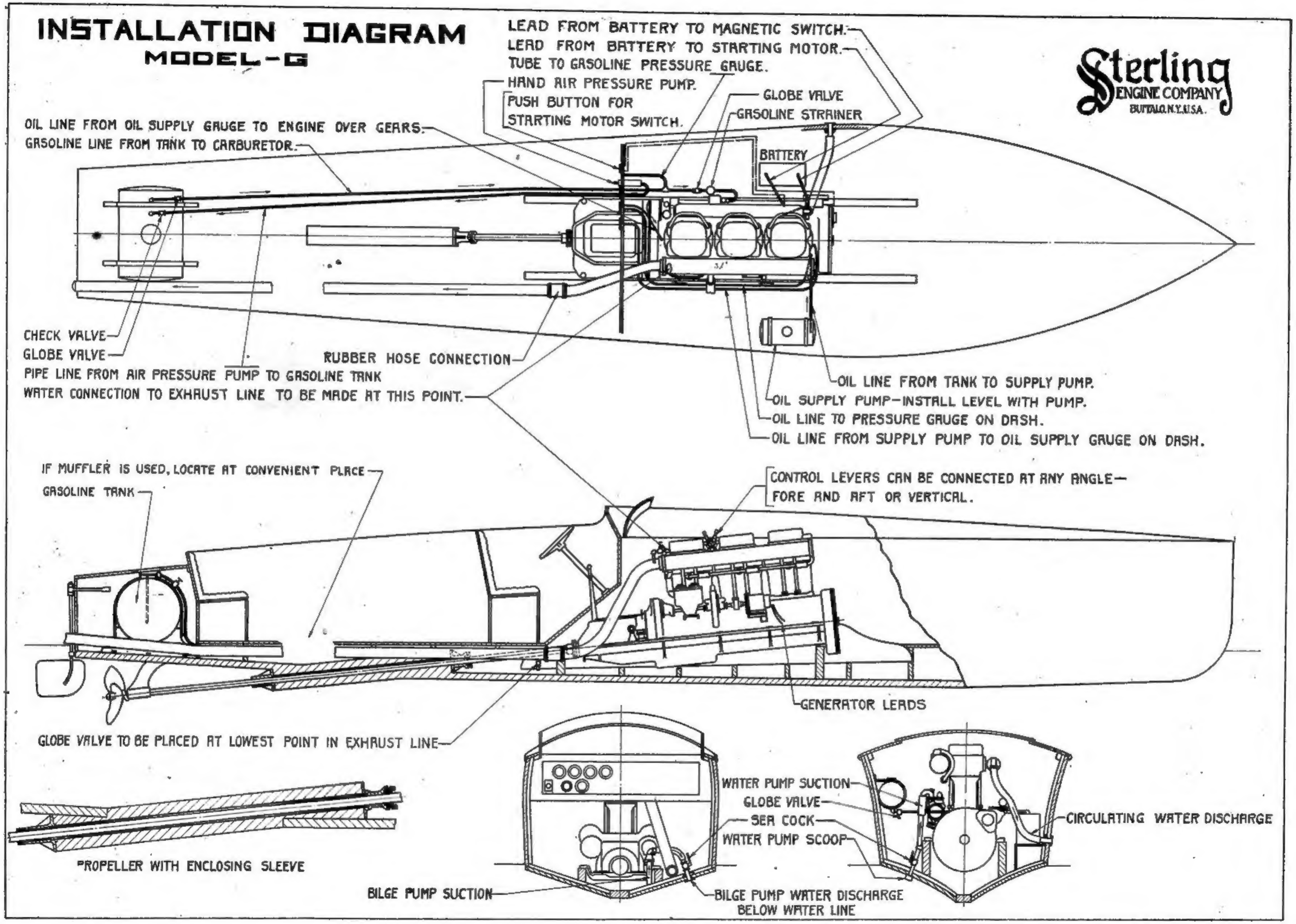


Figure No. 1

INSTALLATION

The New Engine

Before shipping, the engines are completely tested and run in. The test is of sufficient duration to completely test the engine and all accessories. After test the engine is thoroughly inspected and the oil and water drained out.

Installation

It is recommended that the fitting up of the engine in a boat be placed in the hands of competent mechanics, as such work requires considerable skill and judgment. We will endeavor to give enough information, however, to assist those not thoroughly familiar with this work.

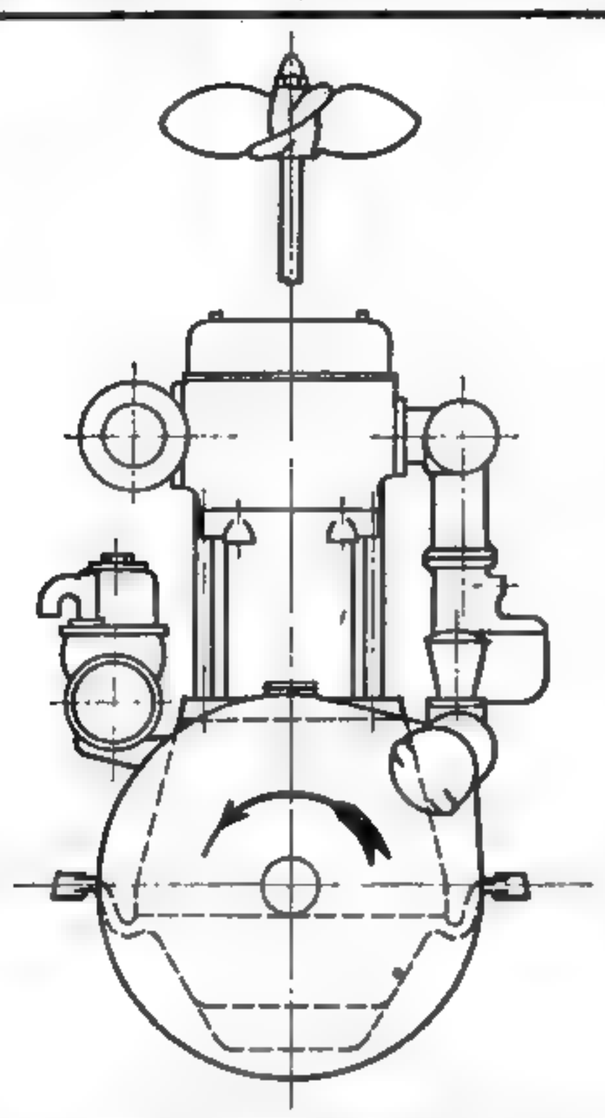
Foundation

The weight of the engine should be distributed over as much of the hull as possible. Foundation timbers should extend several feet beyond each end of the engine. New hardwood not less than 2 in. thick should be used and securely attached to hull with bolts. The top of the foundation should be $\frac{3}{8}$ in. lower than engine supporting flange, so that iron strips can be used on top of timber to protect this and to permit the use of thin sheet metal strips for shimming the engine to the proper position for propeller shaft alignment. Secure the engine to foundation with bolts or lag screws at least 3 in. or 4 in. long to obtain the full strength of the wood. The flywheel housing is designed to fit between the foundation timbers.

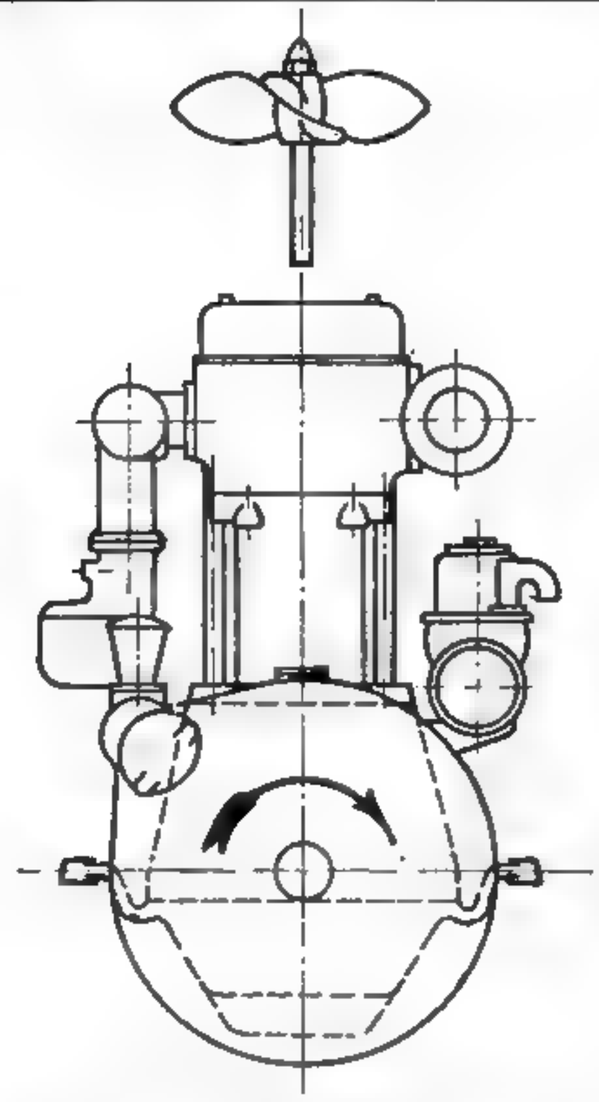
In runabouts, excellent construction is attained by running the keelsons full length of the boat and cross bracing to prevent diagonal weaving. There should be braces at both ends of the engine.

INFORMATION

TYPE "GR" 4-6-8 CYL. $5\frac{3}{4}$ BORE X $6\frac{3}{4}$ STROKE



LEFT HAND ENGINE IS STANDARD WHEN ONE ENGINE IS USED. USE A RIGHT HAND PROPELLER



RIGHT HAND ENGINE USED ONLY ON TWIN SCREW INSTALLATION. USE A LEFT HAND PROPELLER

FIRING ORDER

4 CYL. 1-3-4-2
6 CYL. 1-4-2-6-3-5
8 CYL. 1-5-3-7-4-8-2-6

FIRING ORDER

4 CYL. 1-2-4-3
6 CYL. 1-5-3-6-2-4
8 CYL. 1-6-2-8-4-7-3-5

CYL. No. 1 IS AT FLYWHEEL END.

VALVE TIMING

INLET VALVE CLOSES ON UP STROKE $\frac{5}{8}$" PAST BOTTOM CENTER

EXHAUST VALVE OPENS $\frac{13}{16}$" BEFORE BOTTOM CENTER.

INLET VALVE OPEN AT TOP OF STROKE AT ABOUT THE SAME TIME EXHAUST CLOSES.

VALVE CLEARANCES

THE ENGINE SHOULD BE GIVEN ONE HALF TURN AFTER THE VALVE CLOSES, BEFORE CHECKING THE CLEARANCE BETWEEN END OF VALVE AND ADJUSTING SCREW.

SET THE ADJUSTING SCREW WITH .010" CLEARANCE ON INLET VALVES AND .015" FOR EXHAUST VALVES ON "GR" ENGINES.

ON "GRS" ENGINES SET INLET VALVE AT .011" AND EXHAUST VALVE AT .016".

IGNITION TIMING

PHILBRIN DISTRIBUTOR SHOULD BREAK 1" BEFORE TOP CENTER ON COMPRESSION STROKE WHEN DISTRIBUTOR IS FULL ADVANCED.

Figure A-1

Shaft and Alignment

The propeller shaft should be fitted with a stern bearing outside the hull and stuffing box inside the hull. The hole in the shaft-log should be ½ in. larger than the shaft. A very good method is to use a tube connecting the stern bearing and stuffing box. Both ends of shaft-log must be square with shaft before bolting on the stuffing box and bearing.

The propeller coupling key must be tightly fitted and the shaft spotted with a drill point for the coupling set screws, so that the shaft can not pull out during reverse. Before bolting propeller coupling to engine, see that coupling faces are parallel.

Check alignment by bringing couplings close together, then slide a strip of paper between faces at various points. If faces are parallel, turn shaft half way around and check again with paper. The paper must be gripped uniformly at all points around coupling flange before bolting coupling together. The propeller shaft coupling must run true and free.

When engine is installed in a new boat, check the alignment of shaft couplings again as above. A new hull changes shape somewhat after being in the water some time and the engine may require re-aligning.

Propeller

On cruising or work boats constructed with a heavy deadwood or skeg, the propeller should be mounted a sufficient distance from it (1½ ft.) to insure a free flow of water to the blades, and a support or strut provided on either side of the propeller. Propeller should not be mounted over 5 or 6 inches beyond stern bearing without providing this support. On Runabouts or light cruisers a strut should be placed either side of the propeller. The tip of the propeller blade should clear the bottom of the hull by at least 1½ in. Propellers furnished with engines are balanced and properly fitted to taper on end of shaft when this is furnished. If these parts are not obtained with the engine, they should be carefully checked to insure good fit. Unbalanced propeller, improper fit on shaft, bent blades or close installation to hull or skeg will cause wear on propeller shaft bearings and produce a vibration that would be very objectionable and affect the engine operation.

Exhaust

Run the exhaust pipe outboard as direct as possible. Use tubing with long easy bends, and keep it the full size required for the entire length. Where necessary to make use of screw pipe fittings, avoid 90 degree elbows and use two 45 degree ells instead. Sharp bends or piping too small will cause back pressure and reduce the power of the engine or possibly burn out valves. The entire line should have a gradual drop to drain the water away from the engine. In any low part or in a muffler, a drain for water should be provided. For marine engines the discharge end of the exhaust must be above the water line, or a relief check valve used that will permit drawing in air if the engine should be rotated in reverse direction by a back kick when starting.

A small quantity of water flowing into the exhaust line will cool it and aid in muffling the exhaust noise. On the top of the exhaust manifold on the after end (or on the bottom forward end of GR and GRS engines) a connection threaded for ⅜ in. pipe is provided to supply this water. Discharge cooling water into exhaust pipe as close to manifold as possible.

(See Page 56 for exhaust pipe size)

The water intake fitting must be installed in hull below the water line with scoop opening forward. This should not be at lowest point in hull but somewhat higher where it will be less liable to pick up sand when navigating shoal waters. A sea cock is recommended, attached directly to scoop. A short piece of heavy suction hose 1¼ in. inside diameter is used to attach the 1 in. suction pipe to the engine.

The water overflow is located on the **forward end** of the manifold or inlet side of engine. This should be discharged directly overboard above the waterline. A short piece of steam hose must be used in some part of the line between the engine and hull, as a complete solid pipe line is subject to strains and will leak. 1¼ in. piping and 1½ in. inside diameter hose are required.

Do not pipe the water overflow from the rear end of manifold. Pipe from highest end.

Bases

Marine engines with aluminum lower bases are given a protective coating of paint on bottom outside but when installed must not have bottom in contact with any part of hull at a place where bilge water can come in contact. In sea water, the bilge should be kept free of water at all times to insure proper protection to the engine, as salt water deteriorates aluminum.

For additional information regarding installation, see chapters on

Lubricating	System
Ignition	"
Fuel	"
Exhaust	"
Control	"
Electrical	"

THE ENGINE

Crank Bearings

Crankshaft bearings are babbitt, cast into and firmly secured in the upper crankcase and bearing caps. Bearing caps are steel drop forgings and each one is secured in upper base by four studs fitted with castle nuts and cotterpins. Bearings are located at each end of engine and between each pair of cylinders and have shims which make refitting easy.

Bearings must be kept closely fitted and can be checked by using a pry-bar passing through the hand-hole opening and under the crank. The least play can be felt easily and the test should be made while the engine is hot. To fit bearings, remove castle nuts on one cap at a time with special socket wrench provided. Drop the cap and remove from engine. Examine bearing surface and refit if smooth by removing one shim at a time until slackness is taken up.

Bearings requiring scraping should be carefully worked out with a babbitt scraper having but a slight curve. Put a small amount of prussian blue on crank and turn in with bearing and shims in place, then remove high spots in bearing. Repeat until a good surface is obtained, then fit by shimming. After fitting the bearing should be slacked off by a part turn back of the nuts while the other bearings are being fitted.

Main bearing running clearance on diameter is .002 inches and the end clearance is .015 inches; end clearance of crank bearings is only measured on the second bearing from timing gears. All other bearing end clearances are greater to allow for expansion. Shims are .010 in. and .005 in. thick to allow fitting.

Bronze shells lined with babbitt are fitted into connecting rods which have a removable cap held on with four bolts, each fitted with castle nut and cotterpin.

The bearings may be fitted and checked in the same way as the crank bearings. In fitting new bearing shells, insure that these fit well in the connecting rod or cap by blueing the outside and rocking to locate any high spots. Remove high spots with a fine mill file until shell is well seated. It is just as important to do this as to fit the bearing to crankpin.

Connecting Rod Bearings

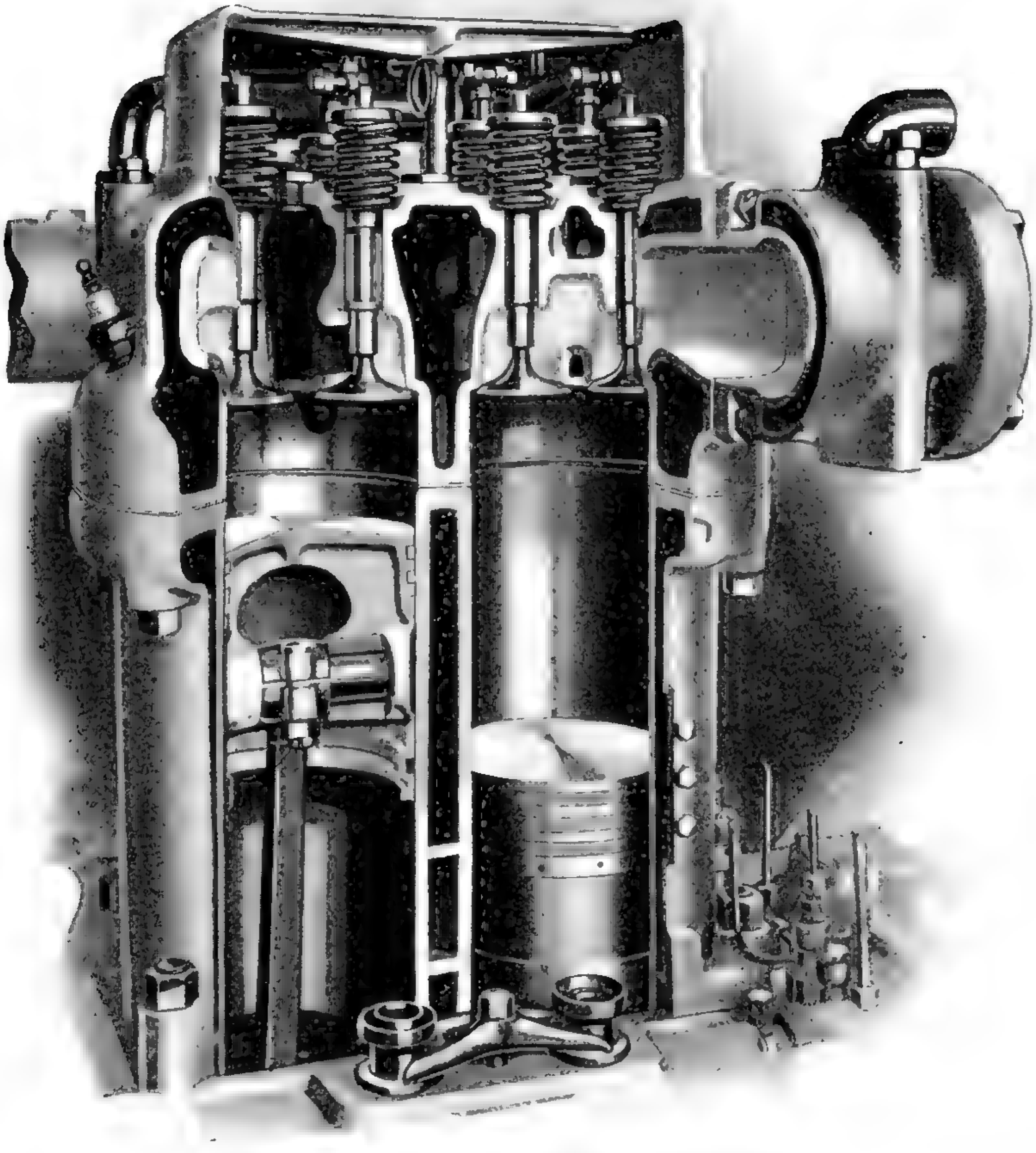
Laminated brass shims are used and one layer may be peeled off by inserting a knife blade under to start it. The small babbitt filler on ends of shim is to be filed down even with brass after peeling.

Connecting rod running clearance on diameter is .0025 inches and the end clearance from .020 in. to .030 in.

When scraping bearings make the radius at the end of the bearing larger than on crank, so that the end movement will be taken up by bearing flanges.

A 1-32 in. relief in babbitt at edge of bearing caps is used. This is simply to break the sharp edge of babbitt and ¼ in. of babbitt at ends of bearing should be left untouched.

When fitting bearings of engine in close quarters, it is frequently convenient to have a bar 2.500 in. diameter so that the bearings can be scraped to fit in outside and then fitted in engine with shims.



Interior of Cylinder Block, Model "G" Engine.

Note ample water jacket space in cylinder head, around valves and spark plugs, and extending almost the full cylinder length. Double valve springs are used. The valves are provided with long removable guides.

Figure No. 2.

Model GRS pistons used on engines operating at minimum full load speed of 1750 r. p. m., are built only of aluminum alloy. Models GR and GM pistons are built of both iron and aluminum and are the same for both models. GH pistons are designed for a lower compression pressure and speed than the GM design.

Piston

Iron pistons are fitted with three compression ring grooves and one oil ring groove each 5-16 in. wide. The oil ring is fitted loosely with .007 in. to .010 in. side clearance in slot. Loose fitting of this ring causes it to act as an oil pump and lubricates the piston wall. The oil is scraped off the cylinder walls by the lower compression ring and returned through drain holes in the piston to the crankcase. The top single compression ring is fitted in the slot with .003 in. to .004 in. side clearance and a pin holds this ring from turning. In each of the two lower compression ring slots, two narrow 5-32 in. rings are fitted with .001 in. to .003 in. side clearance. The gap at the end of the ring should be .010 in. to .012 in. for top ring and .008 in. to .010 in. on others. Bronze bushings are pinned in bosses for wrist pin bearing and pin has .001 clearance in bearing. Clearance of piston in bore should be .004 in. to .005 in. on GH engines and .006 in. to .007 in. on GM and GR engines. This can be measured at open end of piston by using thickness feelers.

Aluminum pistons have four or more narrow compression rings 5-32 in. wide with .001 in. to .003 in. side clearance in groove with .008 in. to .010 in. end gap clearance. Diametrical clearance of skirt should be .010 in. to 013 in. on GR engines and .004 in. to .005 in. on GH engines. Wrist pin fits directly into the aluminum bearing bosses with a hard push fit.

Wrist pins are clamped in connecting rods' upper end. To remove piston from rod, take off cotterpin and nut, push bolt up to ¼ and give bolt a half turn. The pin can then be pushed out of piston easily.

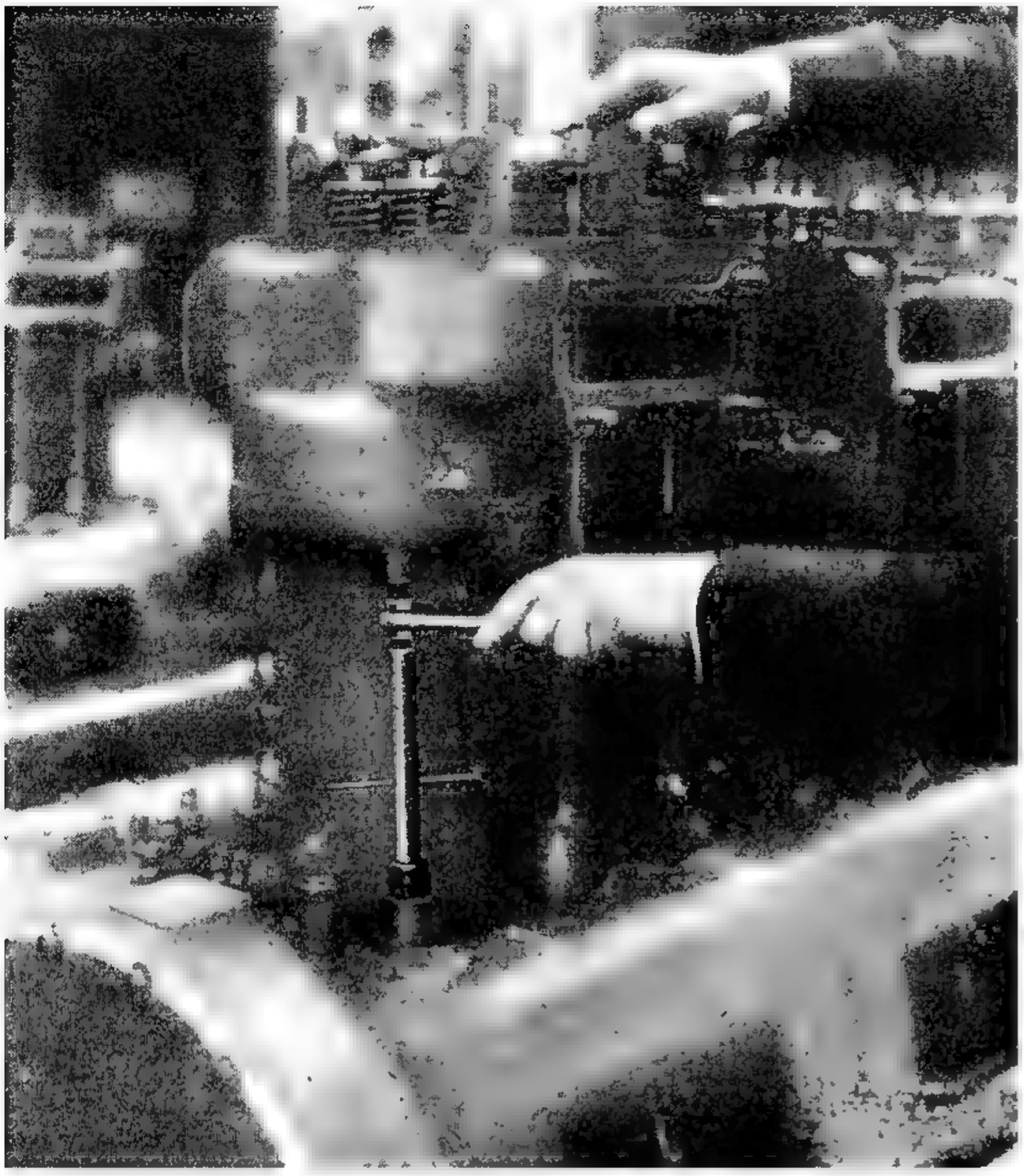


Figure No. 3
Illustrating method of loosening cylinder head studs with special jack, provided with each engine.

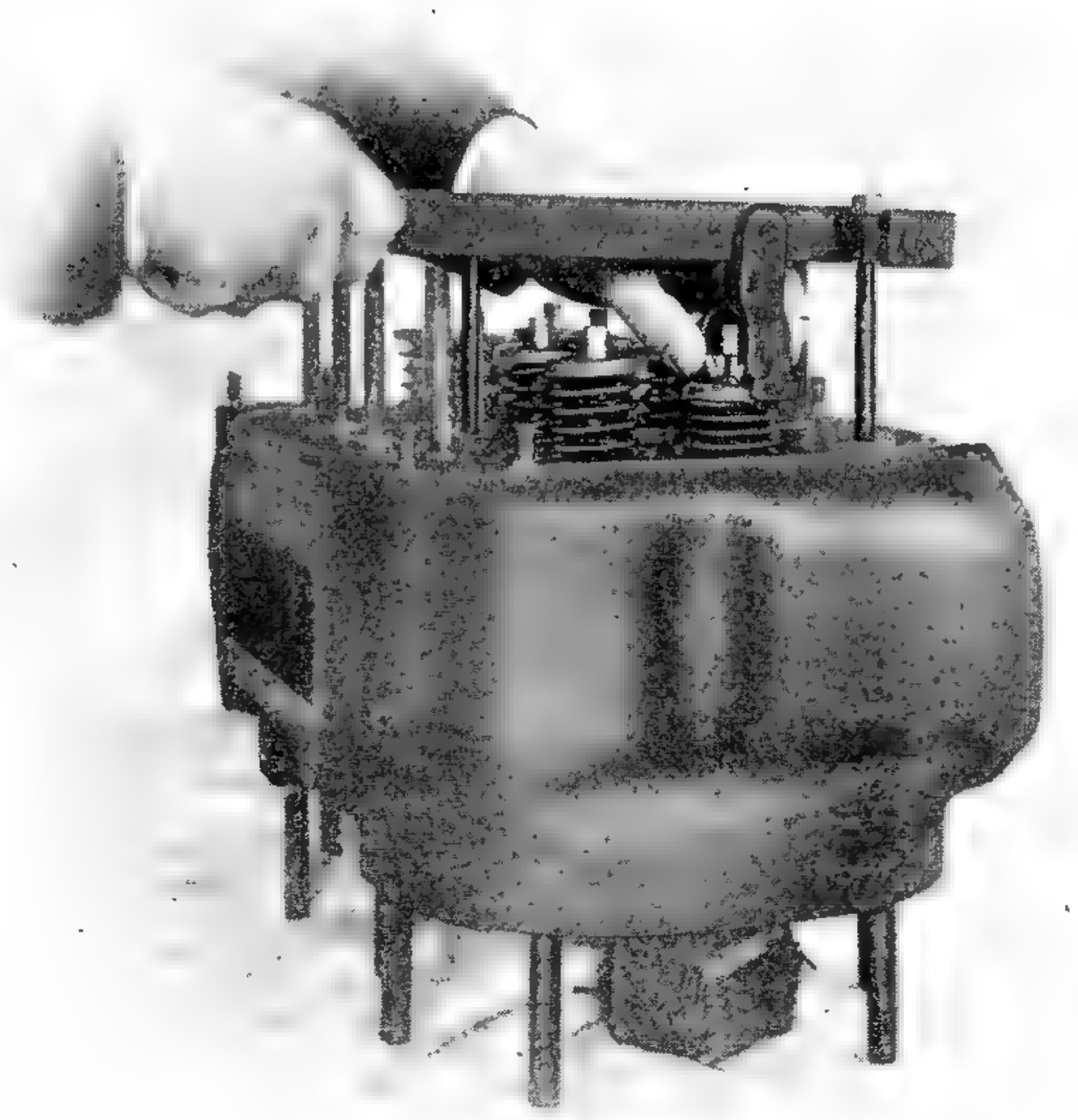


Figure No. 4
Illustrating method of removing valve springs for replacement, using special removal tool provided with each engine.

Cylinder is mounted on lower base and is held by studs and nuts. A heavy vellum gasket is used under cylinder. For tightening the cylinder nut, a special socket wrench is necessary. Large openings are provided on side of cylinder and the plate can be removed to give the water jacket a thorough cleaning should any sediment collect in it.

Cylinder head is attached by studs to the cylinder. All stud nuts are below the flange joint and a special socket wrench should be used. To disconnect the head, remove inlet and exhaust manifolds, water overflow pipes and loosen up packing nuts on push rod tubes. Remove cylinder head nuts and then loosen cylinder head by using the special jack provided. (See figure 3) After head is free, it may be lifted easily. (DO NOT PRY OR DRIVE WEDGES BETWEEN HEAD AND CYLINDER or the finished surfaces will be damaged.)

Cylinder and Head

When replacing head, have both head and cylinder faces clean. Put the small cork gaskets on the water passage ferrules, then put on the copper compression gasket, and carefully lower head to piston.

Head should be assembled dry with new gaskets. For emergency repair shellac may be used by putting on both sides of gasket and allowing it to become partly dry and tacky before assembling. In tightening head nuts, pull up gently and evenly on all nuts and then starting with the opposite center nuts and work alternately opposite toward the ends until all nuts have been pulled up evenly and tightly. After engine has been run and is hot, the gasket should again be tightened. It will be necessary to go over these several times before the nuts are fully drawn up. Failure to properly observe these instructions will result in leaky head joint gaskets. It is not always necessary to disconnect cylinder head to remove pistons, etc.

Before the nuts on head are tightened down, the manifold faces should be lined up by putting the inlet manifold in place and tightening nuts. The manifold can then be removed while the head joints are being tightened. Check and reset the valve rocker, adjusting screws before running. (See valve adjustments.)

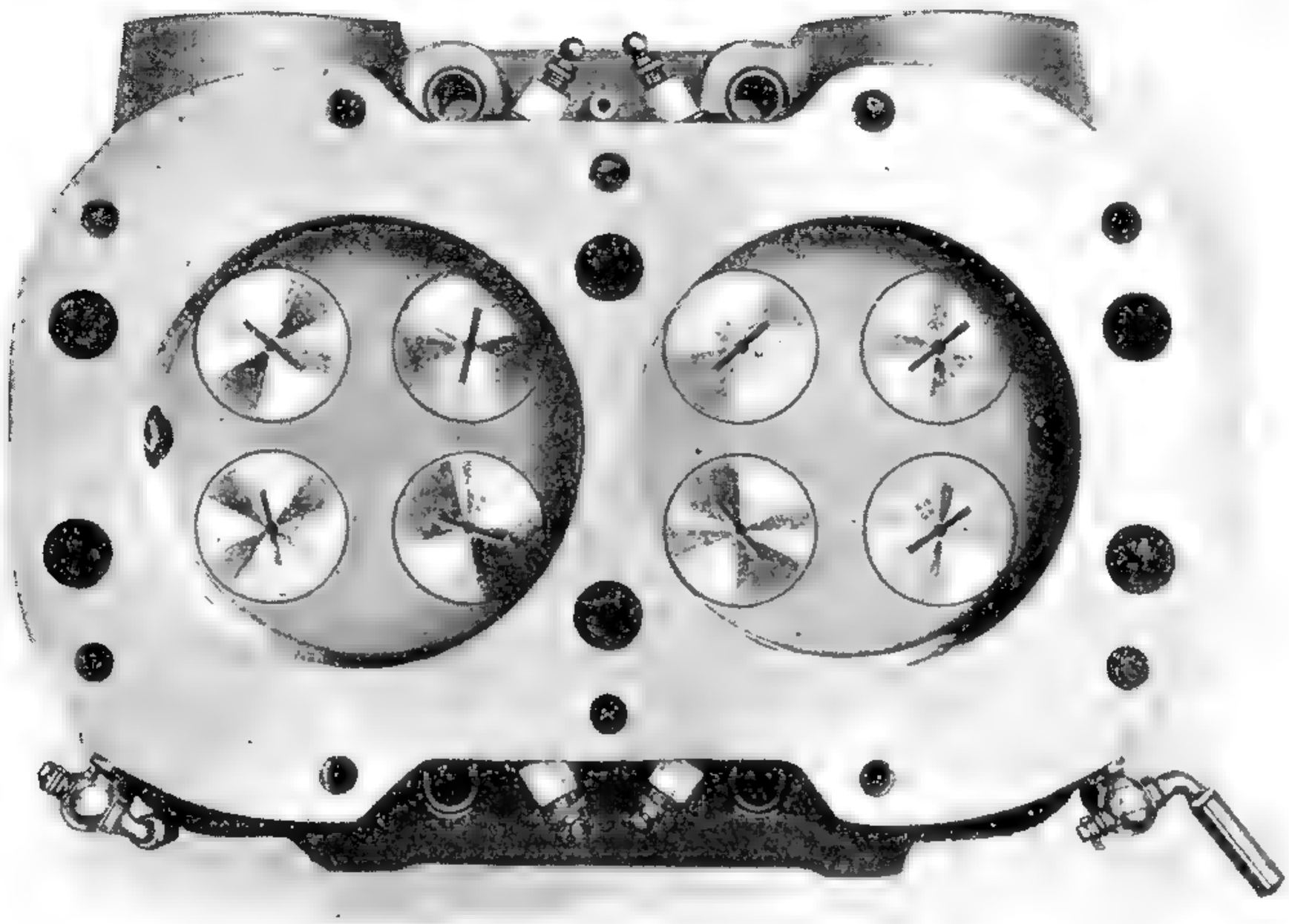


Figure No. 5
Cylinder Head of GR and GRS MOTORS

Showing Duel Inlet and Dual Exhaust Valves

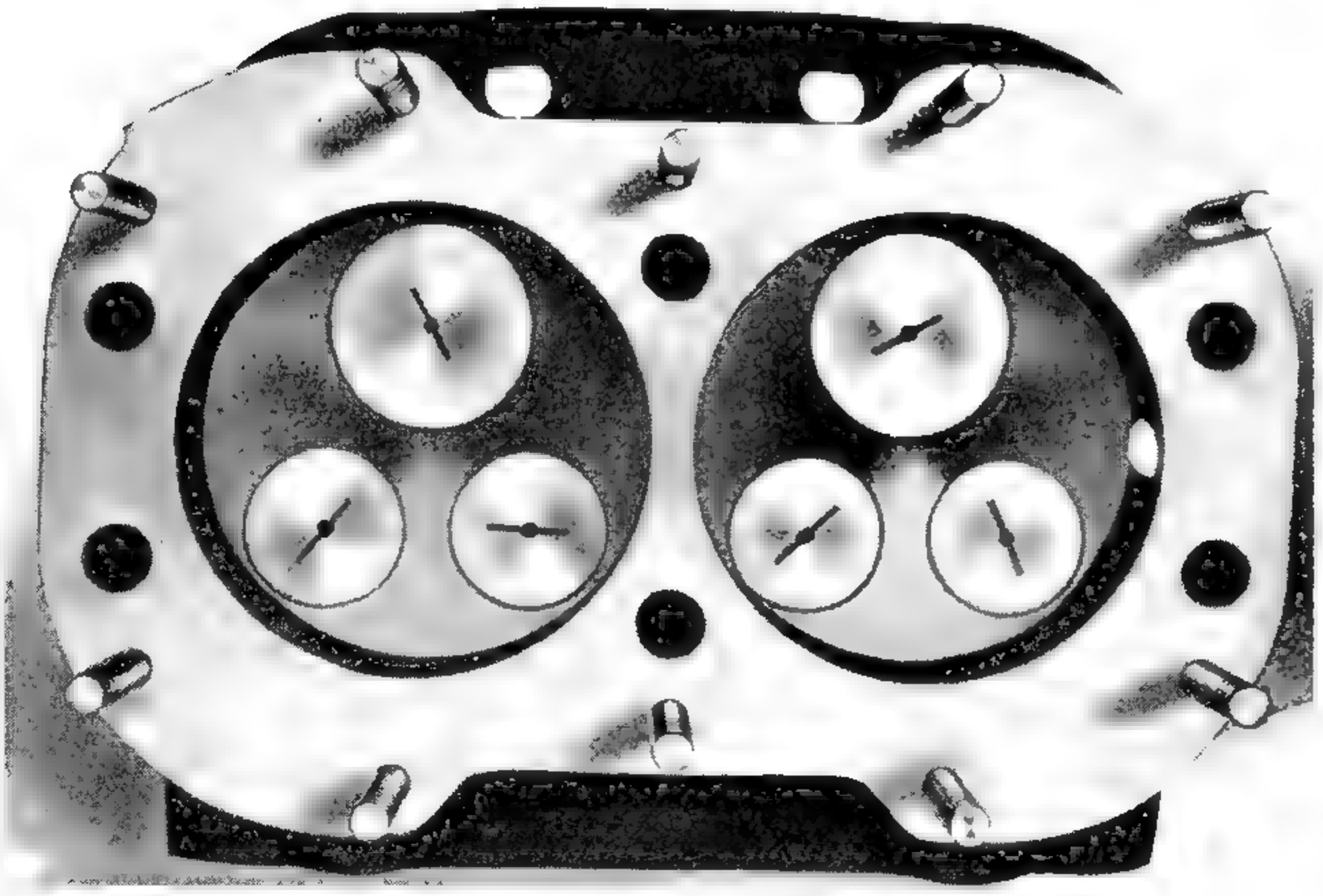


Figure No. 6
Cylinder Head of Model GH and GM Motors

Showing Single Inlet and Dual Exhaust Valves

GR and GRS engines have dual inlet and exhaust valves. (See Fig. 5) GM and GH engines have dual exhaust and single inlet valves. (See Fig. 6) When dual valves are used, these are operated by one push rod operating a forked rocker. (See Fig. 7).

The valves are seated in the cylinder and operate in cast iron guides pressed in head. Two springs are used for each valve and the spring washer is held on by a split collar fitting in a groove on the stem.

Valves

It should not be necessary to grind in valves under 3000 miles of running, as long as proper adjusting screw clearance is maintained. To grind valves it is necessary to remove the head. A special spring removing tool is provided which can be put on stud after rocker bracket is removed. (See Fig. 4) The valve must be held up with a block as shown. Spring can be removed or replaced without taking head off engine by inserting a heavy screw driver through side spark plug opening to hold valve. Be careful to have piston in top position before removing spring washer, so valve cannot drop out of guide.

If inspection shows valves require reseating, a light spring should be put under valve head, so that the valve will be held open just free to seat. A grinding paste made with oil and powdered glass applied in small quantities is to be used, spread evenly over the valve seat. Oscillate the valve with a screw driver, changing its position frequently. The light spring referred to is a great help, as it will lift the valve clear by releasing pressure between oscillations. Clean off the seats occassionally and renew compound until a full seat shows. Do not continue to turn valve in one direction or grooves will form.

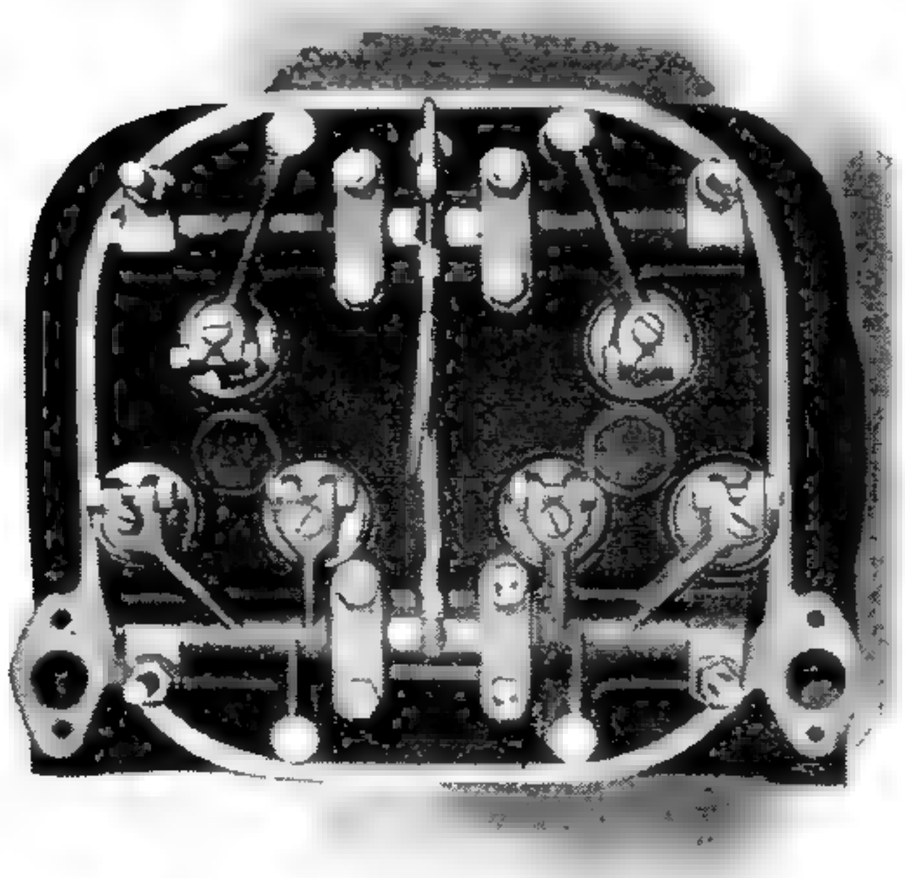


Figure No. 7

Top cylinder head GH and GM engines. (GR is similar.)

The valve adjusting screws are to be set with a clearance of .010 in. for the inlet and .015 in. for the exhaust. The clearance should be determined after valves are fully closed and it is well to set the inlet when the exhaust valve is just beginning to open and the exhaust when the inlet is just closing. After setting clearance, the clamp bolt on rocker should be firmly tightened. Feelers the proper thickness are furnished with the engine.

Setting Valves

The inlet valves are timed to close on the piston travel 5/8 in. up, after passing the bottom of stroke. The inlet opens at top of stroke at about the same time the exhaust closed. The exhaust opens 13-16 in. before bottom of stroke. Measurement can be taken with a rod passing through a guide plug put in the end spark plug hole. It is only necessary to check one cylinder for timing.

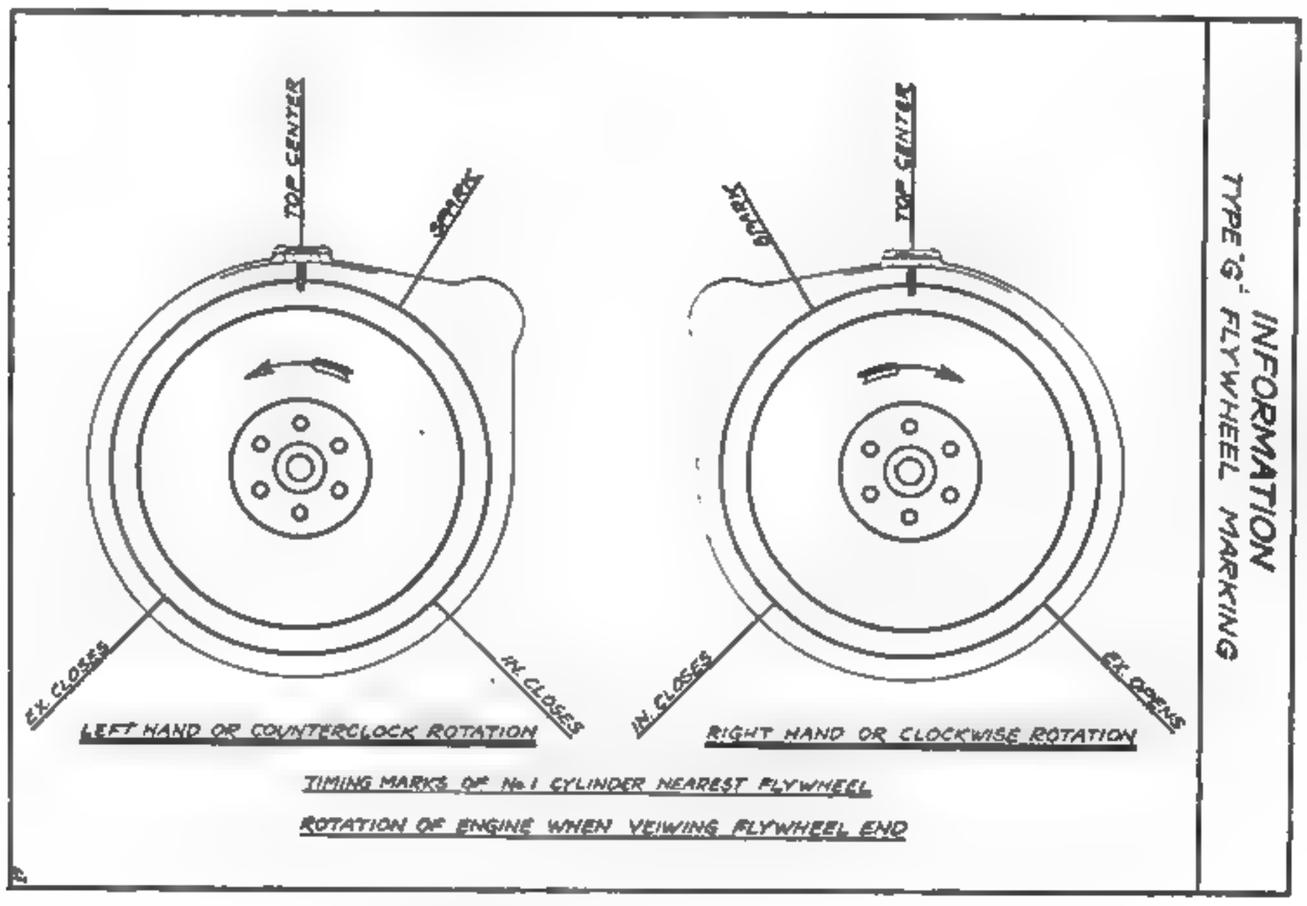


Figure No. 8

Engines built since August 1921 have the timing of No. 1 cylinder marked on the rim of the flywheel. This marking can be observed by removing the small cover on top of flywheel housing. An indicator projects down to the flywheel, which is marked as shown by Fig. 8. Care must be taken to keep flywheel assembled on crank in its proper relation to No. 1 cylinder.

Camshaft

Bearings are located at each end of motor and at the center of each pair cylinders. To remove camshaft, take off timing gear cover, pushrods and handhole plates. Remove screw in bottom of each intermediate bearing; take off camshaft timing gear and screws in flange of bearing at gear end. The shaft is then pulled out three inches and the center bearings taken off, then the shaft can be removed.

End movement of .015 is allowed at gear end bearing and a running clearance in bearings should be .002 in. to .003 in.

Water Pump and Magneto Drive

The entire magneto or distributor drive is removed by taking off distributor and magneto. Removal of three screws holding bearing on to crankcase permits taking off bearing complete with shaft and gear.

Water pump bearing can be removed in a similar manner after taking off the generator, oil cooler, water pump connections and holdon screws.

OILING SYSTEM

Type "G" Engines 5¾ Bore 6¾ Stroke

Pressure System **Supply System**

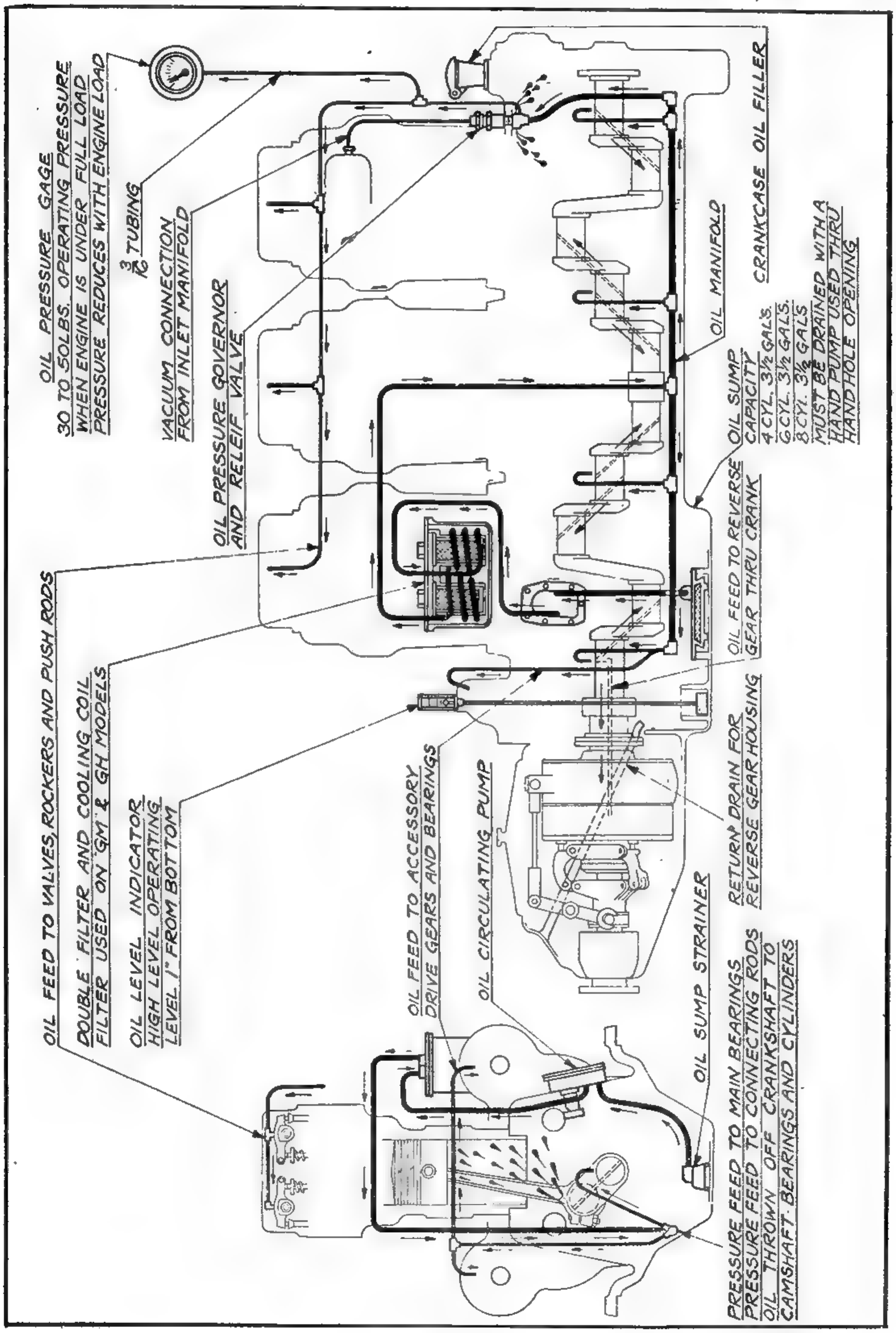


Figure No. 9.

LUBRICATING SYSTEM

The entire lubrication of the engine is automatic except for occasional lubrication of electric starter, generator, magneto, distributor and water pump.

Pressure Oiling

Oil is supplied under presure to all main bearings, connecting rods, timing gears, valve rockers and reverse gear. A pump located on the starboard side of the crankcase at the timing gear end of engine draws the oil up from the crankcase sump and discharges out through the top of crankcase into a filter located above the pump. From the filter, the oil returns to crankcase, passing through the distributing line to the various outlets. Return flow of oil to sump is by gravity. Cylinders are lubricated by the spray issuing from bearing ends.

Oil Sump

The operating supply of oil is carried in a sump in the lower base and is sufficient to fill the engine oiling system. This oil will operate the engine for several hours. In order to keep the sump filled, a fresh oil supply pump feeds oil to the engine at the rate it is consumed.

Oil Level Indicator

The quantity of oil in the crankcase sump is shown by the indicator at the timing gear end of engine. This indicator is operated by a rod connected to a float in the oil sump. When the engine is stopped, the indicator ball should be at the top of the gauge. The ball will drop about 1 in. when the engine starts.

Oil Pump

Before entering the oil pump, the oil passes through a strainer which is made of perforated sheet metal. The openings are large and intended to prevent any large particles that may enter the crankcase from getting into the pump. This strainer is connected to the upper base with a fitting inside rear handhole plate. To remove it, take out two small screws on top ends of strainer which hold it down in lower base, then take off screw at upper end, and which is wired on. When replacing strainer, see that copper washers are put in place on each side of the suction fitting and the screw securely fastened, otherwise an air leak would interfere with pump suction. This strainer should be cleaned occasionally.

The pump is gear construction and is driven from the camshaft by spiral gears. If pump is taken apart, it must be carefully assembled, and turn freely. The end clearance of the gears should be .001 in. and is controlled by using paper shims under the cover. Pump will not maintain full oil pressure if not properly assembled.

After leaving the pump, the oil passes through an outside filter.

Oil Filter

Two strainers are used to provide a large amount of surface. Each strainer is a re-enforced cup easily removed by taking off the screw top. A special wrench is provided for this purpose. The GR, GRS and GRC engines have the filters surrounded by a water jacket containing a coil of pipe through which the oil passes after filtering. The oil is in this way kept cool by the water as it travels from the pump to the cylinder. The GM and GH engines, operating at lower speeds, do not require this additional cooling.

Oil Line

The main oil distributing manifold consists of steel tubing to which branches are brazed and then pressed into bearings and expanded. The entire pressure piping is tested both before and after attaching to engine. This construction insures clean and pressure tight piping.

The connecting rods receive the oil from main bearings through oil holes drilled in crankshaft.

The timing gears are lubricated by a jet of oil which is discharged in pockets.

The valve rockers are lubricated through piping connected from crankcase up through cylinder heads. The oil is fed directly into the hollow rocker bearing shaft under pressure and through small holes in bearings. The oil which escapes from bearings fills small depressions around the valve springs and overflows, returning to the crankcase inside the push rod enclosing tube. Oil in the valve spring depression lubricates the valve stems and the valve tappet.

The push rod rocker cup end is lubricated directly by an oil feed from the rocker bearing. In returning to the crankcase, the oil lubricates the push rod and roller.

Oil Pressure Governor and Relief Valve

On the extreme end of the oil line, after feeds are taken off, a relief valve is located. This valve normally discharges under 25 to 40 pounds pressure during full load running of engine. When engine is throttled, the oil pressure is reduced by the action of the vacuum in the intake manifold. The regulator consists of a ball check valve held to a seat by a spring, above which is a free piston. Above the piston is a cylinder containing a spring and a connection to the intake manifold. Throttling the engine causes the piston to move away from the check and reduce the spring load so that the oil pressure is thereby reduced. Less oil pressure at light loads results in less oil reaching the cylinder walls.

The oil pressure is shown by a gauge mounted on the instrument board.

Fresh Oil Supply Pump

To automatically replace the oil, a feed pump operating at very slow speed is mounted on top of the flywheel end of the crankcase on the exhaust side. This pump has an adjustable stroke, so that the proper amount of oil can be pumped into engine to keep oil level constant. The oil is pumped from an outside oil tank through a sight feed gauge on the instrument board and then into the engine.

Operating Oiling System

The grade of oil to be used is highly important. On engines of this type, a good film of oil is required in bearings. Do not use cheap oils.

The following oils are widely distributed and are recommended for general service:

Liberty Aero Oil, made by Gulf Refining Company.
Texaco Extra Heavy, made by Texas Oil Company.
Gargoyle Mobil "B" made by Vacuum Oil Company.

Should these oils prove too heavy, due to cooler climate or water, the following oils of the next lighter grade may be used:

Universal Gas Engine Oil, made by Gulf Refining Co.
Texaco Heavy, made by Texas Oil Company.
Gargoyle Mobil "BB" made by Vacuum Oil Company

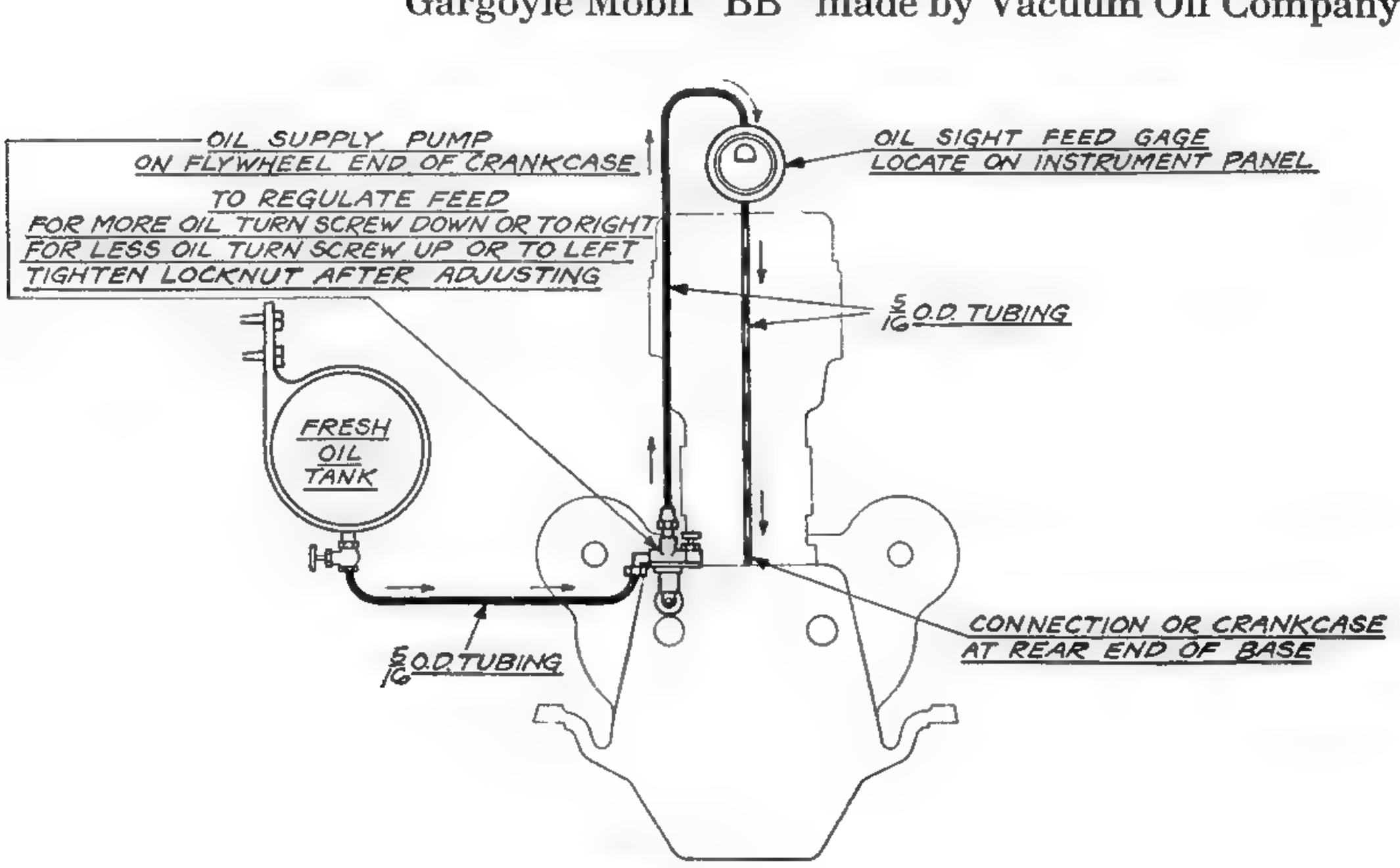


Figure No. 10

Every 500 miles of running the oil should be taken out of the crankcase with a hand pump and 3½ gallons of fresh oil put in the crankcase through the filler over electric starter at flywheel end of engine. Never use WASTE to wipe old oil from crankcase. Clean cheese-cloth or rags without lint are the only safe materials, as lint clogs the oil lines and strainers.

Keep oil level in base from full to one-half full while engine is running. Keep oil supply tank full and supply pump properly regulated to keep oil level constant.

Operating Oiling System

Watch the oil gauge. It will show less than normal pressure when the engine is running light or throttled but must show full pressure when throttle is open. When oil pressure drops, stop engine and investigate the cause. See that crankcase contains proper amount of oil. If full, feel of oil to find out if it has a heavy body.

Important

Thin oil that has been used too long or diluted with gasoline will not show full pressure and will not lubricate satisfactorily. This kind of oil should immediately be replaced with a fresh supply.

Next, be sure that filter strains are clean, as these collect foreign matter and should be cleaned regularly—on a new engine, every two-three days and thereafter as found necessary. Should pressure then fail to build up, thorough examination should be made that the pump is working, oil regulator is not stuck and that no leaks exist. Loose or worn main bearings will permit oil to flow too freely and should be taken up if loose.

COOLING SYSTEM

Cylinders and exhaust manifolds are cooled by circulating water from outside the hull through them. The water is drawn in through a scoop or strainer on the bottom of the hull through piping to the pump. A sea-cock should be installed close to the hull and used to stop flow of water during any time that the engine is disconnected. A short piece of heavy suction hose is used to connect piping and pump in order to avoid straining solid pipe connections from vibration or hull deformation.

A gear pump on the engine is driven from the timing gearing. The pump is made of bronze to withstand corrosion from sea water. On GR, GRS and GRC engines, the water flows through the oil cooler and exhaust manifold jacket before entering cylinder jacket. On GM or GH engines, the water flows directly into cylinder jacket and then into exhaust manifold jacket. On eight cylinder engines, metal reducing plates are used between paper gaskets on top of cylinder where water outlet pipes are connected to equalize the flow of water in all cylinders.

Overflow connections must be made the full size of discharge fitting on engine and connected with a hose as part of the piping. Do not use a shut-off valve in this line.

Keep all connections on engine as well as suction and discharge lines tight. Sea Water leaking on engine will corrode aluminum and iron readily.

Water pump packing must be kept tight with graphited hemp packing.

A primer plug is fitted on top of pump suction and if pump does not pick up water at once on a new engine, water must be poured in to prime pump. After the initial priming, pump should pick up water at once unless drained. If pump fails to work properly, the gears should be examined.

Care of Cooling System

Two grease cups are fitted to water pump and must be kept full of light medium grease that will flow under the spring pressure. If the light grease flows too easily, the regulator on the side of the grease cup hexagon can be adjusted to reduce the flow.

Owing to the use of bronze to resist corrosion, and to the speed of the pump, the gears wear and will probably require replacement each season, as sand and foreign matter aid the water in wearing the gear teeth. This replacement can be made either by removing the generator, taking pump cover off and loosening pump, or by removing entire shaft and bearing.

During freezing weather, the pump, oil cooler, exhaust manifold and each of the cylinders must be drained while engine is idle.

IGNITION SYSTEM

GR and GRS engines have three, and GM and GH engines have two spark plugs per cylinder. Regular ignition equipment on GR and GRS engines is three distributors. Previous to using all battery distributor ignition, a two spark dual magneto with vibrating battery spark for starting and one battery distributor with automatic advance was used. GM and GH engines are fitted with vibrating spark distributor and an independent magneto with automatic impulse coupling. Previous equipment was a single spark dual magneto with vibrating battery spark for starting and an automatic advance distributor.

A vibrating spark is almost essential to insure positive and easy starting of large engines.

A dry cell battery is recommended for starter purposes on all engines, as the voltage of the storage battery drops while starter is cranking engine.

Only good grade of ignition cable is used. High tension wires between coils and battery or magneto distributors should always be as short as possible and we recommend that the coils or switch be mounted on engine if possible. Do not run ignition wires in tubes about boat, unless it is of large size, well ventilated and drained. High tension coil wires must never be run in a conduit with other wiring.

Additional detail information on magneto, distributors and coils can be obtained from the instruction books of the manufacturers of these instruments.

Spark Plugs

Porcelain spark plugs, such as Bethlehem No. 027 or Champion No. JS43, are recommended. These plugs have 7/8-18 SAE thread and a one piece shell with 1-1/8 in. hexagon to fit the special wrench furnished. The spark plug should not be over TWO INCHES long from shoulder forming gasket seat to the end of terminal. A longer spark plug would interfere with the spark plug wrench and bring the terminals too close together, causing the spark to jump to the next plug. It is impossible to use many of the long plugs on the market, owing to the construction of the engine, as the spark plugs enter the cylinders at an angle. The spark plugs below the shoulder should measure about 5/8 to 3/4 inches to the sparking points. The gap of spark plug should be about .020 in. to .025. This is the thickness of the two valve adjustment feelers used together.

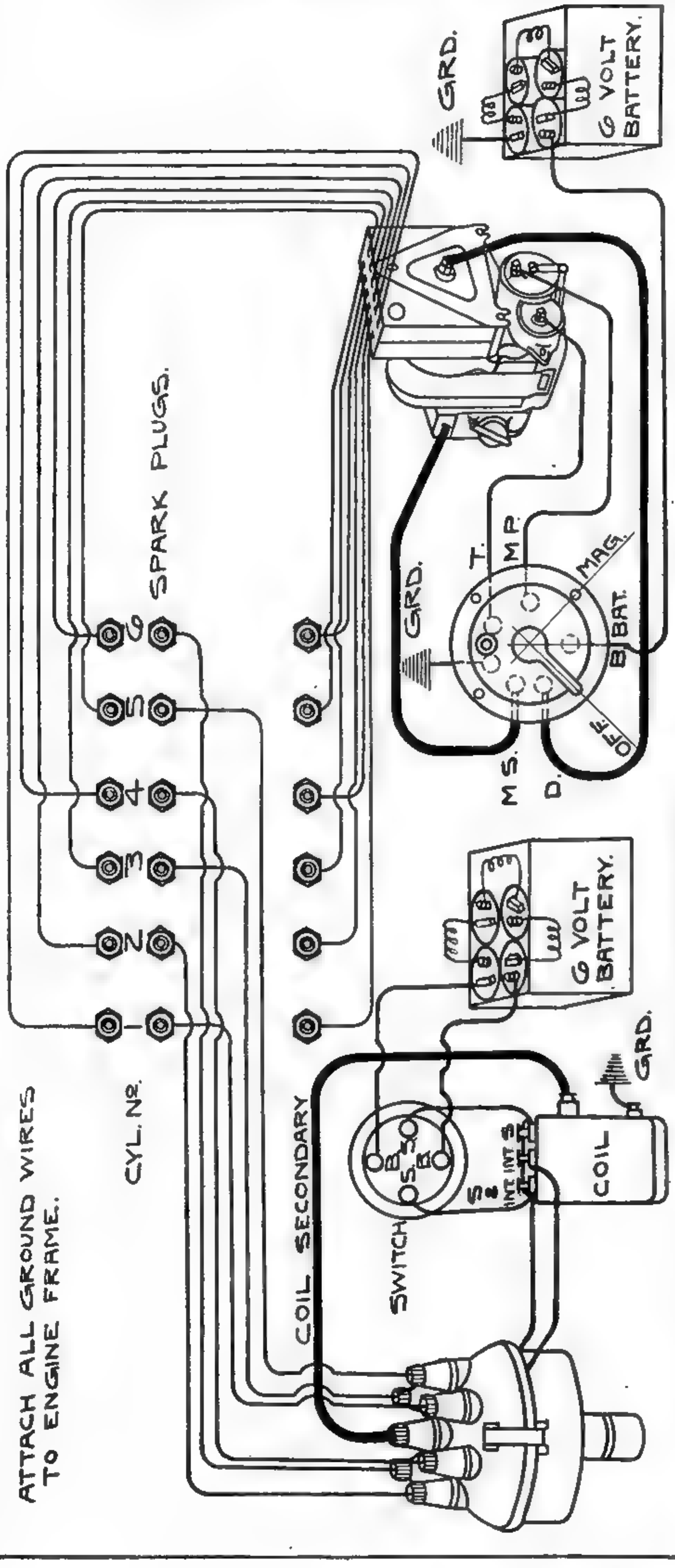
GR Two Spark Dual Magneto and Automatic Advance Distributor for GR Engines (Earlier Models)

The two spark Berling Dual Magneto was fitted so that the front end set of plugs fire the plugs on the EXHAUST SIDE and the rear distributor fire the plugs on TOP OF CYLINDER. The magneto is a Berling "DD" two spark with a Berling "SC4" coil in which the switch is built. The switch has the operating position "OFF" "BATTERY" and "MAGNETO." As high tension wires are used between coil and magneto, it is advisable to have these as close as possible. In cruisers, the coil should be mounted close to or on the engine. (See wiring diagram Fig. 13).

The magneto has a battery interrupter which is timed to fire 20 degrees of crankshaft travel after the magneto interrupter. This is done to have retarded spark for starting, as there is not enough movement to magneto spark control for the full running advance required and retard. A dry cell 6-volt battery is used for starting as the service is intermittent.

IGNITION SYSTEM

TYPE GR ENGINES — 5 3/4 BORE X 6 3/4 STROKE.



IGNITION SYSTEM.

BERLING MAGNETO MODEL DD66 WITH BERLING TYPE SC4 COIL.

WIRING—WIRE CABLE IS USED. HEAVY LINES INDICATE HIGH TENSION CABLES AND SMALL LINES INDICATE LOW TENSION AND SMALL CABLE SHOULD BE USED. LIGHT LINES IN SERIES OR SIX VOLT STORAGE BATTERY. IF DRY CELL CURRENT IS WEAK USE NEW CELLS OR MORE IN MULTIPLE. SIX DRY CELLS AND WATERPROOF CASE ARE FURNISHED WITH MOTOR.

STARTING—PUT MAGNETO SWITCH IN BATTERY POSITION. CHANGE MAGNETO SWITCH TO MAGNETO POSITION AFTER STARTING. TURN OFF SWITCH TO STOP.

COILS—MOUNT IN DRY PLACE AND CONNECT TO SIX VOLT BATTERY. USE FOUR OR SIX DRY CELLS IN SERIES OR SIX VOLT STORAGE BATTERY. IF DRY CELL CURRENT IS WEAK USE NEW CELLS OR MORE IN MULTIPLE. SIX DRY CELLS AND WATERPROOF CASE ARE FURNISHED WITH MOTOR.

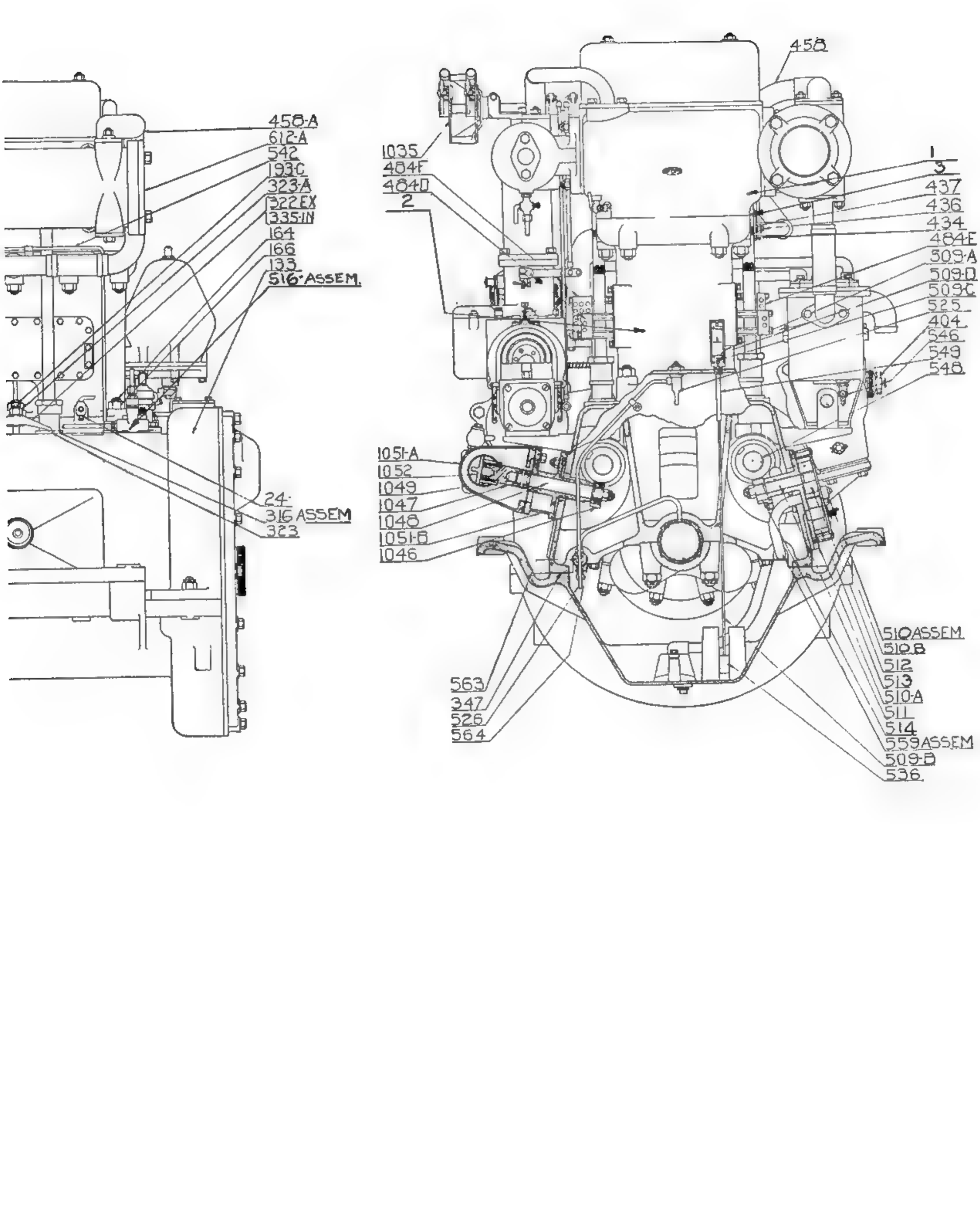
CONTACT POINTS OF BREAKER—.016 TO .020" APART ON MAGNETO. ADJUST WITH GAUGE FURNISHED WITH MAGNETO. .010" TO .012" APART ON DISTRIBUTOR. KEEP POINTS CLEAN AND PROPERLY ADJUSTED.

SPARK POSITION—MAXIMUM ADVANCE FOR MAGNETO IS ONE HALF INCH ON PISTON TRAVEL OR 28° ON CRANKSHAFT, BEFORE TOP CENTER OF COMPRESSION STROKE.

SPARK PLUGS—KEEP PLUGS CLEAN. POINTS SHOULD BE ABOUT 1/32 APART.

GR Berling DD66 and Atwater-Kent

Fig. 13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193-C
323-A
322 EX
335-IN
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166
133
516 ASSEM.
24
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323
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484-F
484-D
2
1
3
437
436
434
484-E
309-A
509-D
509-C
525
404
546
549
548
1051-A
1052
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1048
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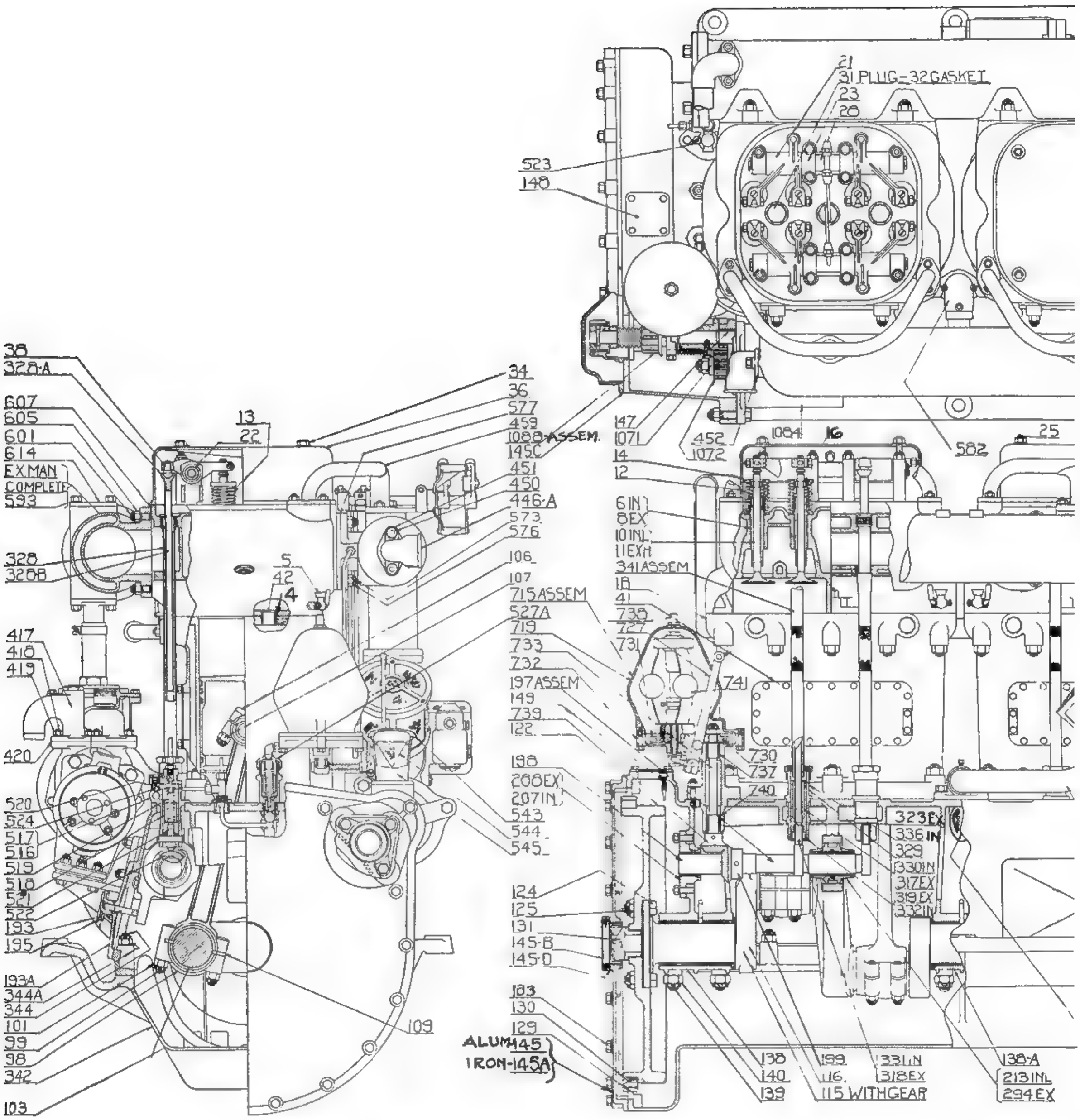
509-B
536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328B
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518
521
522
193
195
193A
344A
344
101
99
98
342
103
13
22
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42
4
34
36
577
459
108 ASSEM.
145C
451
450
446-A
573
576
106
107
715 ASSEM
527A
719
733
732
197 ASSEM
149
739
122
198
208 EX
207 IN
543
544
545
124
125
131
145-B
145-D
183
130
129
ALUM 145
IRON-145A
109
523
140
21
31 PLUG-32 GASKET
23
28
147
107-1
452
107-2
14
12
6 IN
8 EX
10 IN
11 EX H
341 ASSEM
18
41
730
727
731
741
730
737
740
323 EX
336 IN
329
330 IN
317 EX
319 EX
332 IN
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16
582
25
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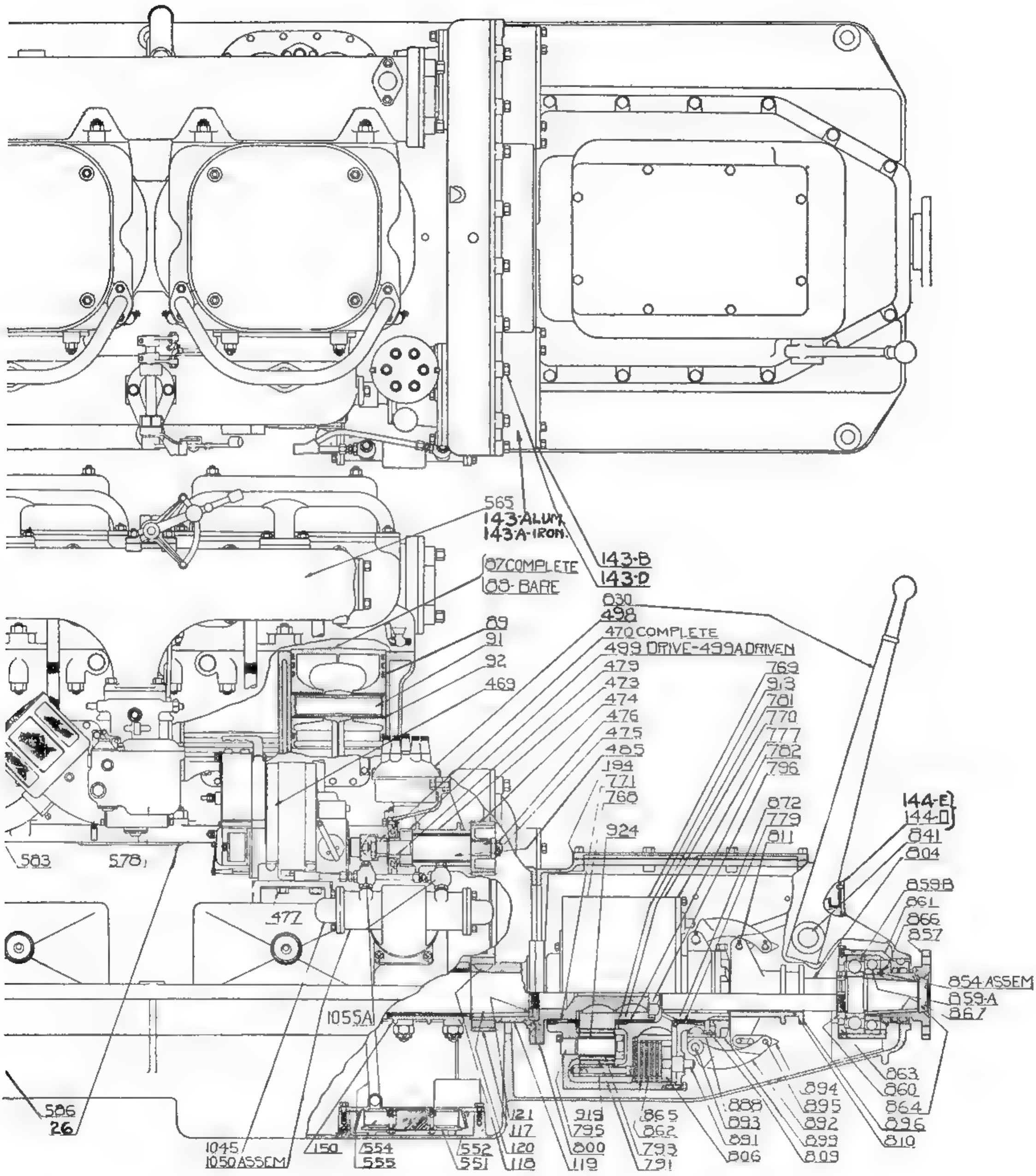
140
139
199
116
115 WITH GEAR
133 IN
318 EX
138-A
213 IN
294 EX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143-ALUM.
143-A-IRON.
143-B
143-D
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88-BARE
030
498
470 COMPLETE
499 DRIVE-499A DRIVEN
89
91
92
469
479
473
474
476
475
485
194
771
768
769
913
781
770
777
782
796
872
779
811
924
144-E
144-D
841
804
859B
861
866
857
854 ASSEM
859-A
867
503
578
477
1055A
586
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1045
1050 ASSEM
150
554
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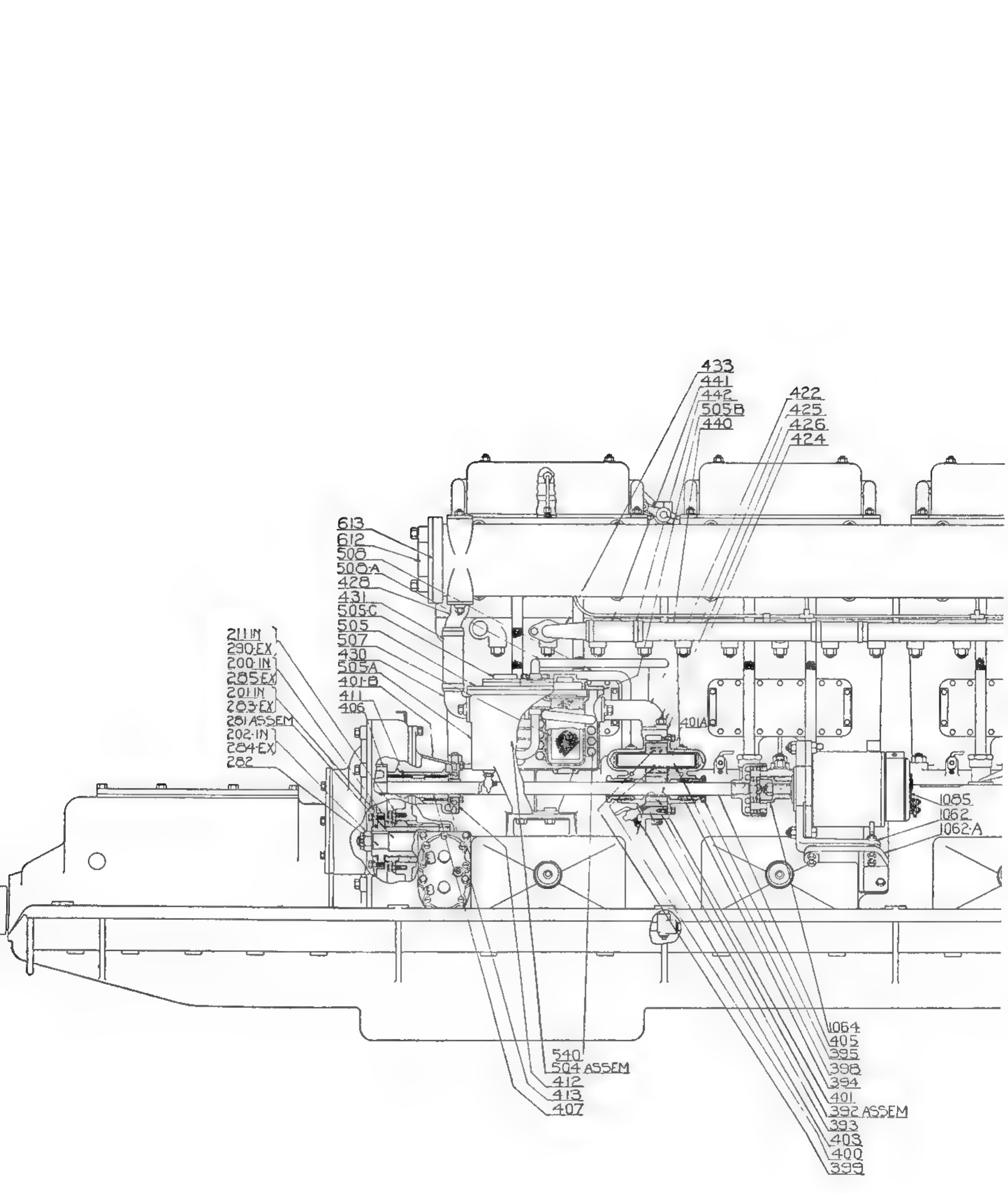
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508-A
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505-C
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401-B
411
406
211 IN
290-EX
200-IN
285-EX
201-IN
283-EX
281 ASSEM
202-IN
284-EX
282
401A
1085
1062
1062-A
540
504 ASSEM
412
413
407
1064
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401
392 ASSEM
393
403
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399

Care of Berling Dual Magneto

The magneto is attached to engine and sealed after testing to insure it being properly timed. The Sterling Engine Company cannot be responsible if trouble develops from changes of timing and magneto if seal is broken. The spark is set to fire 9-16 in. of piston travel before top center of compression stroke. Adjust breaker points every 50 hours of running. Use gauge furnished with magneto and set points not less than .018 in. or more than .020 in. when the fibre lever is on the center of the cams. If points are rough or pitted, these must be smoothed with a fine file, so that contact is obtained over entire surface.

Distributor blocks on magneto having carbon brushes should be removed every 24 hours of running and both blocks wiped off with a cloth soaked with kerosene or gasoline. Gap distributors do not need this attention but the distributor finger can be adjusted if found necessary in order to maintain a gap of from .008 to .015 inches.

To set magneto timing, the spark lever must be placed in full advance position. The magneto attaching screws must be removed, the magneto slid away from coupling, then the shaft can be rotated to the correct position and the magneto again attached with slight end play in coupling.

Lubrication of Berling Magneto

Put a thin film of vaseline on cams and fiber lever of interrupter every fifty hours of running. Do not oil interrupter or platinum points. Every fifty hours put ten drops of light cylinder oil in each oil cup.

Care and Maintenance of Berling Magneto Coil

In order to adjust the vibrator, the switch should be thrown to the battery position and the knurled nut around the push button turned in a clockwise direction as far as it will go. The switch cover is then easily removed and the vibrator tension can be adjusted by turning the insulated screw. The vibrator contact itself can be turned and if necessary completely removed by means of a screwdriver. It is not advisable, however, to readjust this contact unless absolutely necessary. The spring tension should be adjusted until a high frequency spark is obtained. This is practically all the adjustment necessary. The cover should then be replaced, turning the knurled nut in the opposite direction to lock it in place.

In case of trouble, note the following:

If the coil vibrates all the time, the timer circuit is open. If the vibrator does not work at all, the battery circuit is open or the push button is open. If the vibrator is pulled down against the coil all the time, the timer contacts do not open. If the vibrator pulls down and releases properly, but does not vibrate when released, the ground circuit is open. If the vibrator works properly but no spark occurs at the secondary, there is trouble with the winding and the coil must be repaired.

The distributor is mounted in bearing and is driven from magneto shaft with spiral gears. Angular adjustment to proper position is obtained by turning distributor body and a set screw inside of bearing holds it in position. The distributor is operated from a 6-volt dry cell battery, as very little current is used.

Atwater-Kent Type K-2 Unisparker

To time distributor, set piston of No. 1 cylinder past top center and then rotate distributor body left hand until click occurs. This will be a firing position with safe retard.

Maximum engine output is not obtained with the above timing but by moving distributor slightly in each direction when engine is running wide open and setting where the highest speed is noted, this can be obtained. As a retard setting is necessary for starting, this should be checked again after the power setting is made.

The normal gap between the contact points is from .010 in. to .012 in.—never closer.

The contact points are made of purest tungsten, which is many times harder than platinumiridium.

Contact Points

When contact points are working properly, small particles of tungsten will be carried from one point to the other, sometimes forming a roughness and a dark gray color on their surfaces. This roughness does not in any way affect the proper working of the points, owing to the fact that the rough surfaces fit into each other perfectly. However, when it becomes necessary to take up the distance between these points, due to natural wear, it is advisable to remove both contact screw and spring contact arm, and with a new fine file dress down the high spots.

This makes it possible to obtain a more accurate adjustment and eliminates any danger of high points on either contact touching each other when system is at rest.

Please bear in mind that these contacts are very hard to file and that it is necessary to remove only a very small amount of metal. Please also remember that although the contact surfaces may be very rough, they are probably in perfect working condition, the dark gray appearance being the natural color of the tungsten.

Oiling IMPORTANT

The other parts of the contact maker—the latch, lifter, lifter-spring and notched shaft—are not adjustable, and are not subject to wear if they are cleaned at intervals of a few weeks. (Note oiling diagram Fig. 14). Take care to avoid getting oil on the contact points.

CAUTION:— Do not think that these parts do not work properly because you cannot see their movement, which is far too quick for the eye to follow. The contact maker of the Unisparker may be likened to a watch, which, because of the small size and extreme accuracy and hardness of its moving parts, is subject to little or no wear even after many years of service. Both the latch and lifter are of glass-hard steel and move only a short distance for each operation. Under no circumstances should they be altered in shape, nor should the tension or setting of the springs be changed. These are set right at the factory, and are the result of years of painstaking standardization.

Oiling Diagram
Atwater-Kent
Unisparker

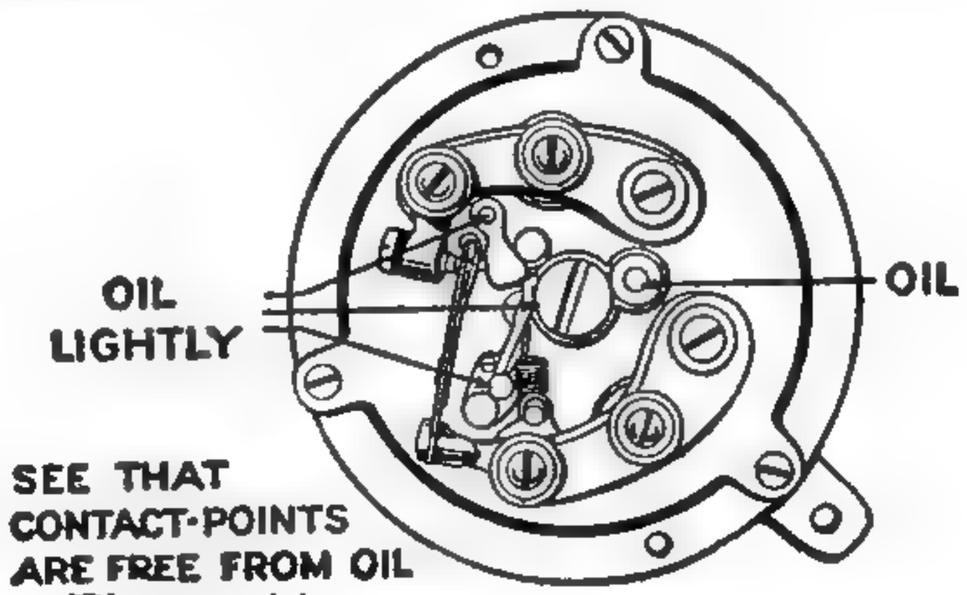


Figure 14

Single Spark Dual Magneto and Automatic Advance Distributor for GM & GH Engines

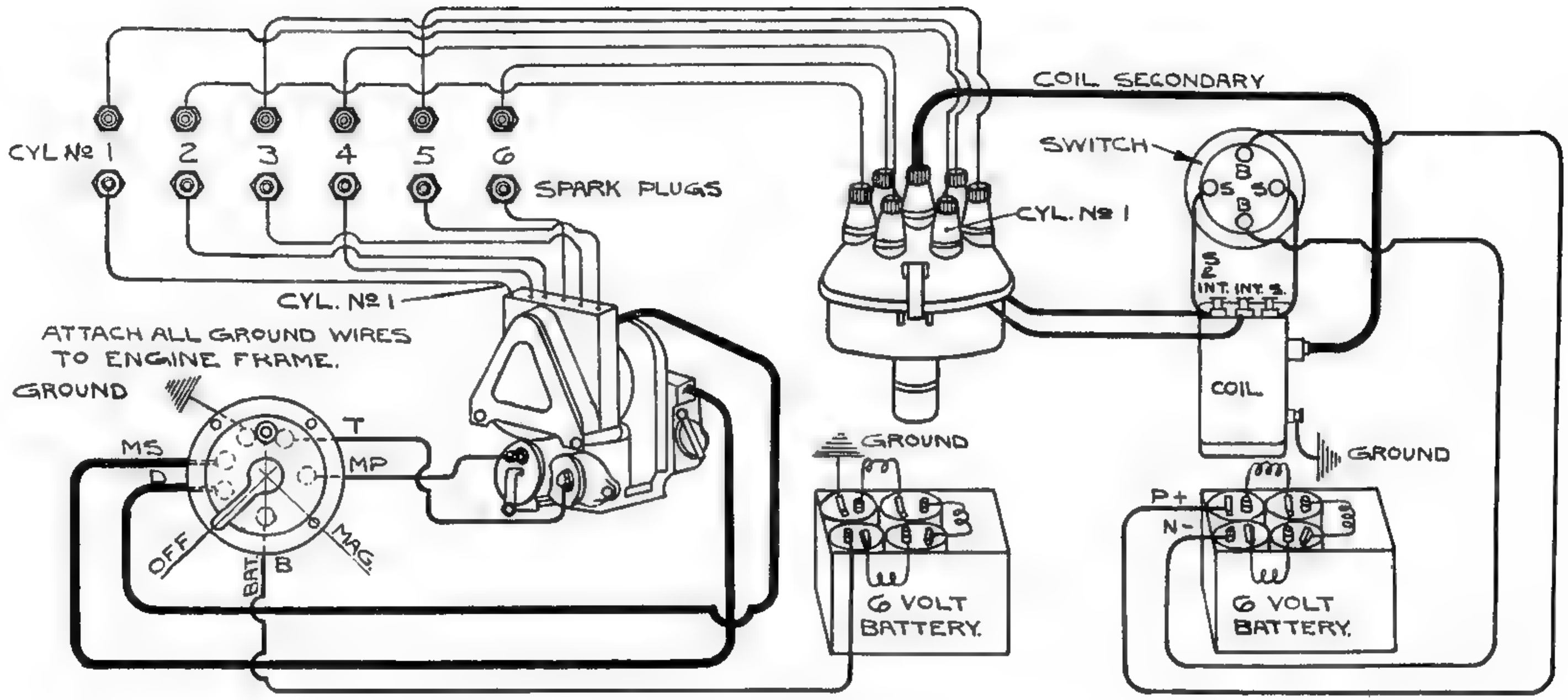
See Wiring diagram Fig. 15. Except for a difference in construction of the SC-3 coil switch used with the "DD" single spark magneto, and the use of only two sparks on each cylinder.

The description and care of dual two spark Berling magneto used on GR and GRS apply to the single spark dual Berling magneto and the same Atwater-Kent distributor is used. The magneto fires the plugs on top and the distributor on the side of cylinders.

IGNITION SYSTEM

Simms Single Impulse Magneto and Phil-Brin Dist. for GM & GH Engines

See Wiring diagram Fig. 16. The Simms Type "ZK"magnetos with impulse starter are used with a Phil-Brin Duplex Single Distributor. The impulse coupling on magneto operates only at low cranking speed and it cuts out of operation as the engine runs at speed. An automatic retard of spark is obtained when impulse is working but spark should be retarded for starting in order to retard distributor. The magneto should be assembled on engine without any end play in the coupling. Push the magneto tight against rubber coupling after timing magneto. Engines have magneto attaching screws sealed after testing and the timing should not be altered. If magneto should be removed, it becomes necessary to retime when attaching it. Turn engine to firing position on compression stroke of No. 1 cylinder and set magneto distributor to fire at proper terminal. To set magneto, rotate in reverse direction until contact closes, then rotate armature in proper direction until contacts open, then put rubber coupling in position and attach magneto. The spark lever should be advanced while timing and spark should occur one-half inches for magneto and ¾ in. for distributor of piston travel before top center of compression stroke.



IGNITION SYSTEM

GM&GH Engines–5¾ Bore, 6¾ Stroke.

Fig. 15

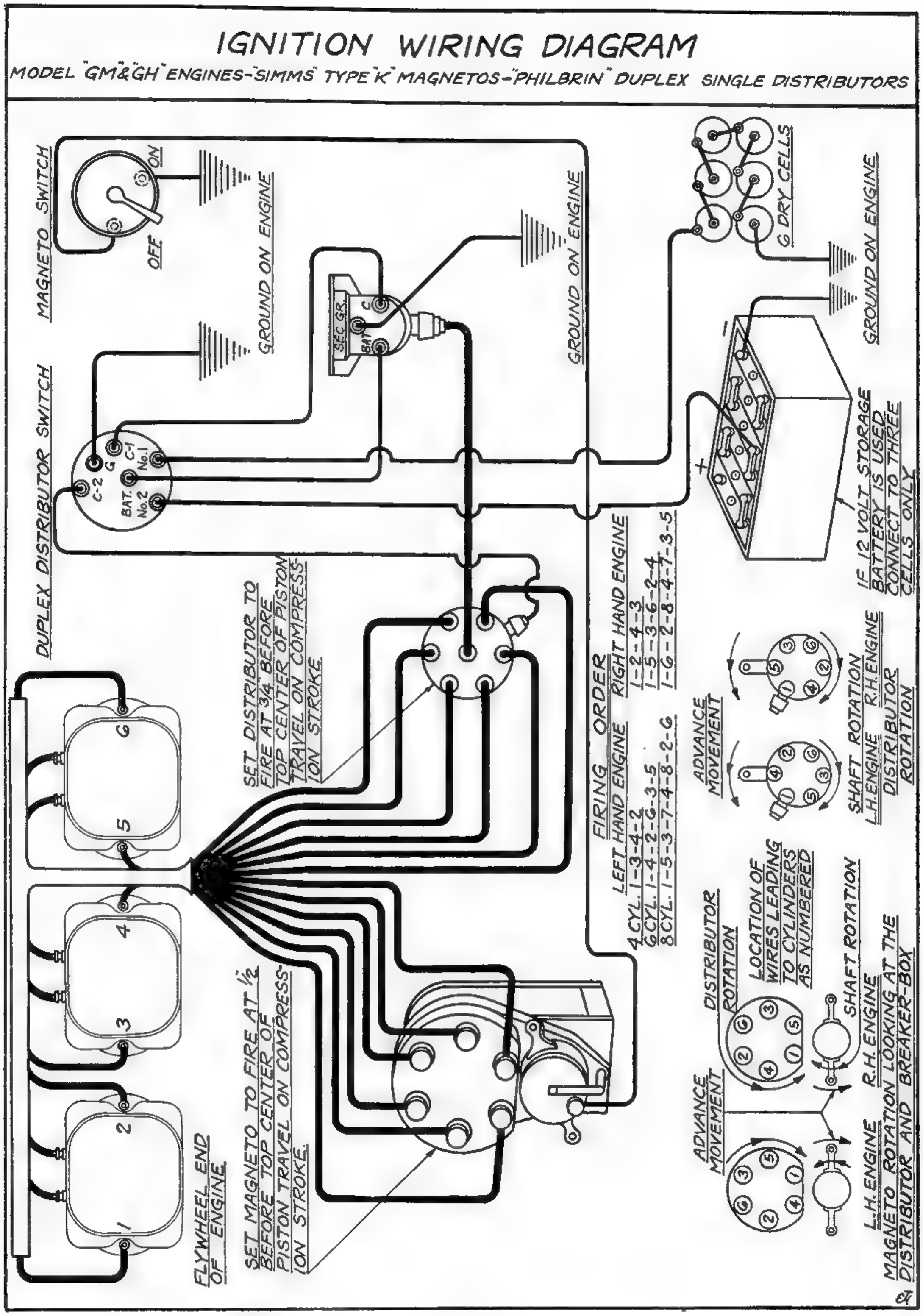


Figure 16

GM and GH Diagram.

Care of Simms Magneto

The platinum points should be set so as to open on each cam about 1-64th of an inch, or the thickness of the gauge on the wrench furnished. These points should be kept clean and free from oil and should make even contact with one another, over their entire surfaces. The contact breaker lever should pivot freely in the bushing. The contact breaker should be inspected occasionally and freed of dirt and oil. Only if it should become absolutely necessary should the platinum points be filed, and then only with a very fine, flat file.

Cable connections should be kept tight and occasionly the inside of the board wiped with a very dry cloth to remove any oil or dirt. The distributor carbon brush should at all times press firmly against the board.

The safety spark gap is to protect the insulation of the magnetic armature from injury caused by excessive voltage, which would occur should a high-tension connection become loose or taken off, as the spark will then jump at the safety spark gap. If sparking should be detected in the safety gap, which is reached by removing the front hood or cover over the driving spindle, the high-tension wiring should be gone over carefully at both the magneto spark plug and spark plug ends. The distributor carbon brushes should be examined to see if they are in condition and making contact with brass segment on the distributor rotor. If sparks can be obtained at the safety gap, it is an indication that the magneto is generating, and that the trouble is most likely in the wiring or spark plugs.

The magneto should be oiled every two weeks or 1,000 miles run with four or five drops of light (not cylinder) oil in each of the oil holes, which are located over the armature driving shaft and near the top of the distributor board. The contact breaker should never be oiled; it may cause serious difficulty if oil is allowed to remain on it.

Phil-Brin Distributor

The Phil-Brin distributor is cared for as described in the "GR" distributor instructions on Phil-Brin ignition. On the "GM" and "GH" engines, the distributor must be timed to open contacts at the same time that magneto contacts open when spark lever is fully advanced. To obtain close timing, a slot is provided in the control lever under distributor body. Be careful not to have the screw which holds the distributor down in its place from binding hard and interfering with the advance or retard. The distributor ground wire should be fastened under the head of this screw. On distributors not fitted with this wire, the operation is the same, only sparking in the control rod joints may be noticed at times. By using a few drops of heavy oil in these joints, this sparking is easily eliminated. Connect this distributor with 6-Volt BATTERY ONLY. Do not put 12 volt battery on this circuit.

GR & GRS Engines with Triplex Double and Duplex Single Battery Distributors

See Wiring Diagram Fig. 17.

Owing to the greater reliability, battery ignition is used on the high speed engines. Phil-Brin ignition has both single and vibrating spark. The vibrating spark makes starting easy under conditions that the single spark would not start engine. It is necessary to use metal conduits grounded on engine to carry the spark plug wires, owing to the high voltage of this system. The Triplex double system operates from the 12 volt starting battery and the Duplex single system can be connected to the center of the battery, as this must operate ONLY ON A 6 VOLT circuit. An additional 12 volt and 6 volt dry cell battery should be used for emergency running and engine should always be started on these batteries. The Triplex double distributor is connected to spark plugs, so that forward distributor fires plugs on top and the rear distributor fires plugs on exhaust side of cylinders. The Duplex single distributor fires plugs on inlet side of cylinder.

Phil-Brin Duplex Double Ignition System

This system is mounted on the magneto base and is the same as right and left hand engines, except the drive is taken on opposite end of shaft. Only one contact is working with either system switch position. The 12 volt primary current flows through two 6 volt coils in series, so that both sparks occur simultaneously. Should any trouble occur with the contact points, the switch can be thrown to other system position and bring the other contact maker into use. The vibrating spark is obtained without use of primary contacts in distributor, as a vibrator coil is part of the switch and the high tension distributor times the spark which occurs continuously.

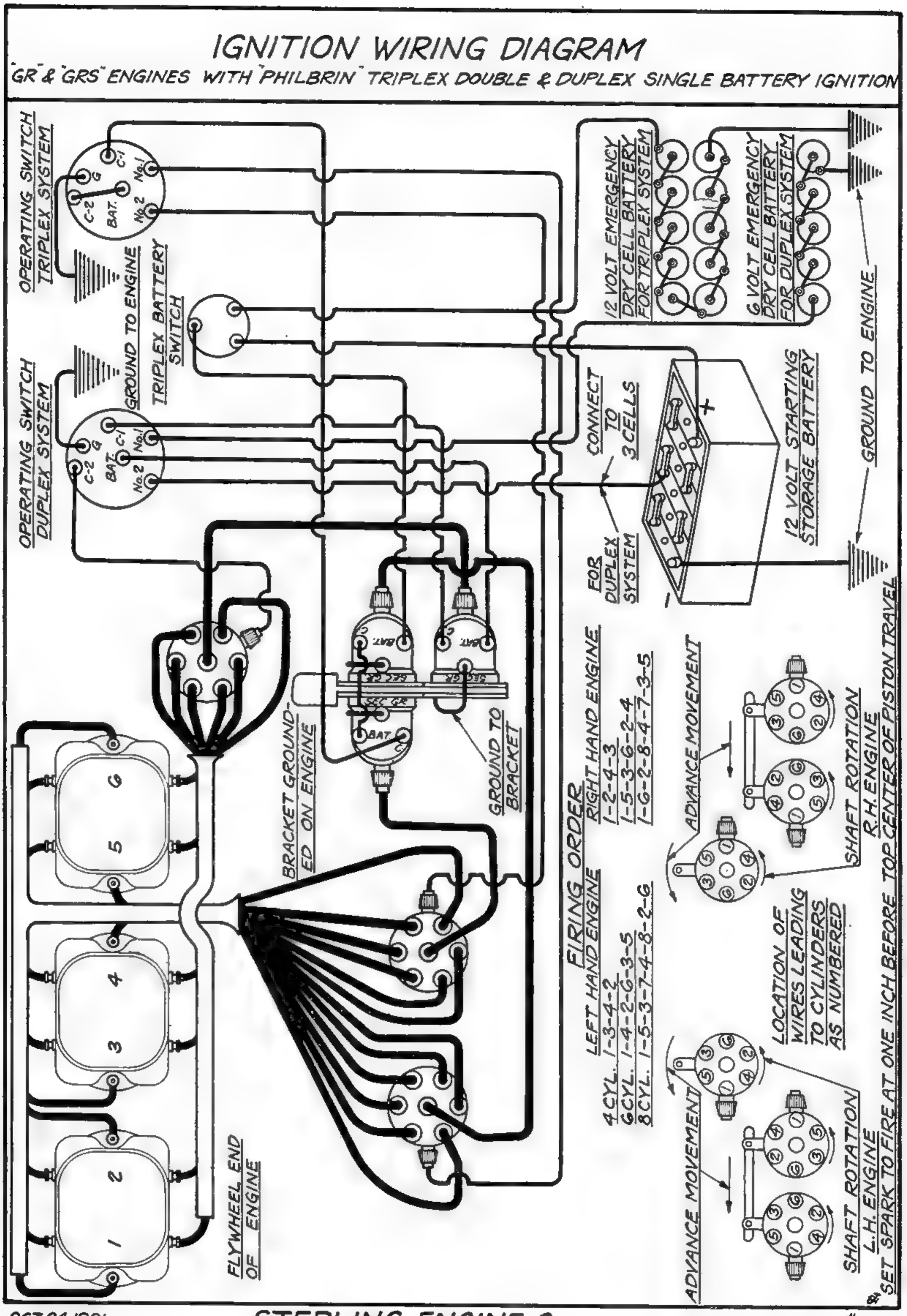


Figure No. 17

GR and GRS Ignition Wiring Diagram.

Phil-Brin Double Duplex Ignition System

This system is for emergency and starting purposes only. When engine is operated on it, the spark lever must be retarded one-third, as this spark occurs earlier than that from the timer contacts. Spark should occur 1 in. before top center of piston travel and should not be altered. The distributor is timed to fire as the contact opens and the same method followed otherwise regarding coupling and attaching as described in magneto instructions.

After timing distributor in advanced position, see that a safe retard spark occurs at least ⅛ in. down stroke past top center.

CAUTION: If distributors are removed from magneto base mounting, be sure that each one is replaced with the shafts in the same position, otherwise the firing will not be correct.

The contact points should be adjusted .012 in. to .015 in. apart. To clean contact points, first apply light oil to points and then make smooth by using a fine file. While doing this, hold the tee plunger so it does not swing back and forth.

Do not use sand paper or emery cloth to clean points, as the abrasive material will work into plunger, causing it to stick.

Distributor oil cup should be filled once a month and a few drops of oil placed on end of steel plunger, where it comes in contact with the cam.

Should any wear occur to the plunger or bridge holding it in place, these parts must be replaced together with a new spring.

The Duplex Single Distributor is set to fire at the same time as the double distributor.

Phil-Brin Duplex Double Ignition System

The Phil-Brin distributor is cared for as described in the GR distributor instructions on Phil-Brin ignition. On the GM and GH engines, the distributor must be timed to open contacts earlier than the magneto contacts open when spark lever is fully advanced, as shown on wiring diagrams. To obtain close timing, a slot is provided in the control lever under the distributor body. Be careful not to have the screw which holds the distributor down in its place from binding hard and interfering with the advance or retard. The distributor ground wire should be fastened under the head of this screw. On distributors not fitted with this wire, the operation is the same, only sparking in the control rod joints may be noticed at times. By using a few drops of heavy oil in these joints, this sparking is easily eliminated. Connect this distributor with 6 VOLT BATTERY ONLY. Do not put 12 volt starting battery on this circuit.

The ignition coils must not be mounted on engine so that no high tension wires are taken away from engine.

The switches are connected as shown on wiring diagram and while the engine can be started on the single spark under ordinary conditions, the high frequency system is recommended and the dry cell batteries.

FUEL SYSTEM

The carburetors on the engine are connected with suitable piping in turn to a gasoline strainer shut-off valve to the fuel tank. A gravity flow of fuel with a minimum drop of one foot is the simplest fuel feed. Most boats are designed so that it is not practical to locate tanks for gravity flow and it is necessary to pump the fuel to the carburetor. Common pump construction has not proven satisfactory as gasoline is a very difficult liquid to handle, as it wears pumps rapidly and will leak out through any bearing or packing. The air pressure systems have proven to be the most reliable and simple, and from a low pressure air pump, a pressure sufficient to lift the gasoline to the carburetor is maintained in the tank. A hand pump is used to supply the pressure for starting. (See Fig. 16)

Carburetor

Regular equipment on GR has been one and GRS engines two 2½ in. carburetors; on GM and GH-6 cylinder engines, 2 in. carburetors, and on GH-4 and 8 cylinder, 1¾ in. carburetors. In 1922, on Model GR six cylinder engines, two 1¾ in. carburetors were adopted. The several sizes and types of Stromberg carburetors are constructed differently but the same general instructions apply. All sizes are of the plain tube type.

The Stromberg marine carburetors are of the plain tube type, having no automatic air valves or other moving parts except the throttle and float mechanism; all the gasoline for normal running is taken through one regulating opening, and the proper mixture proportion is maintained by the principle of taking air into the jet passage along with the fuel, so that an emulsion of air and gasoline discharges from the jets. At very low idling speeds, the gasoline from the main jet is carried up in a passage at the side of the carburetor, and discharged from an idling slot at the lower edge of the throttle.

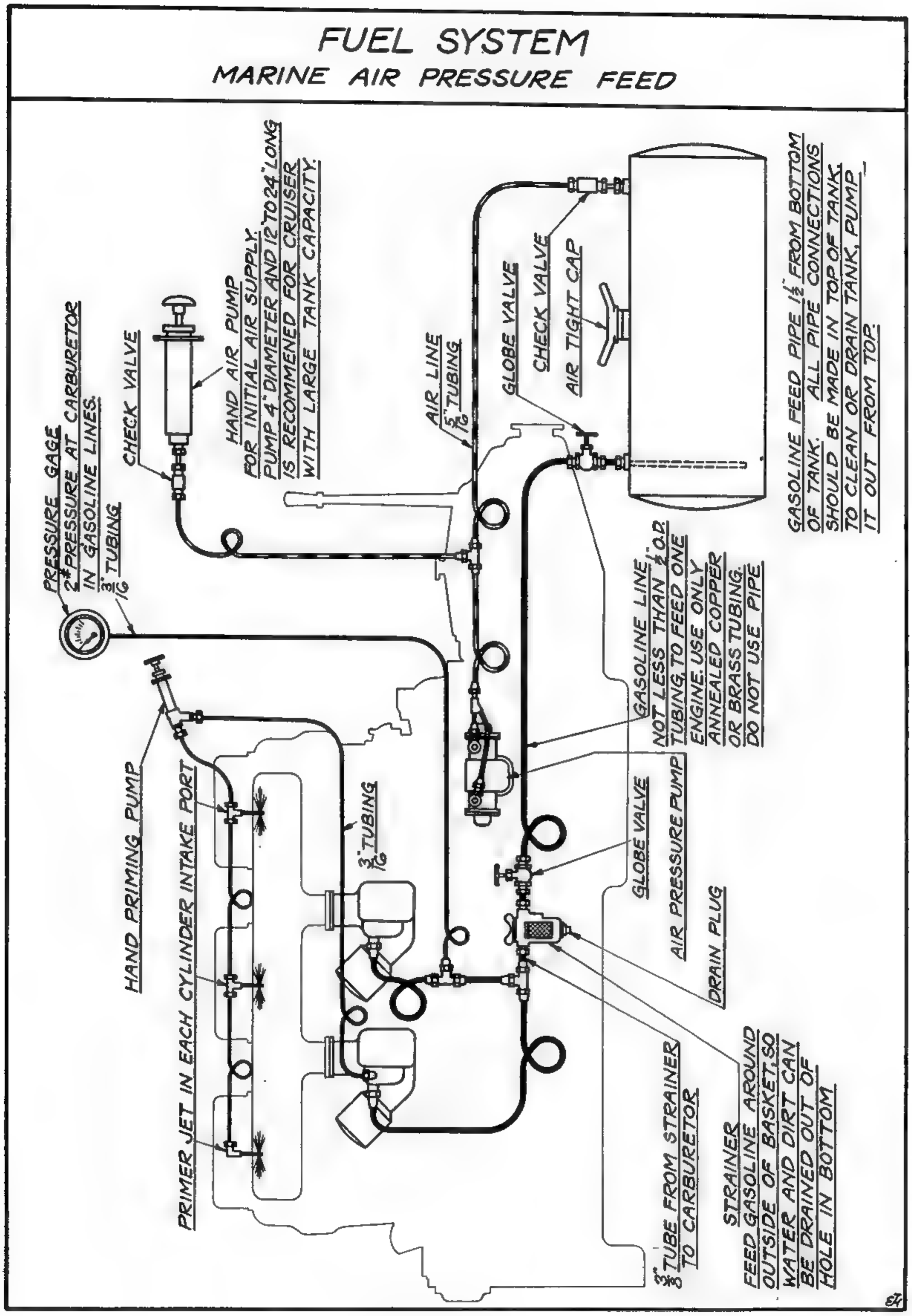


Figure No. 18

Fuel System

The gasoline pressure of one to two pounds should be measured from pipe line between strainer and carburetor. Any stoppage of fuel line or strainer will then be quickly found. Do not attempt to use vacuum tanks. A vacuum tank will seldom pump enough fuel with throttle wide open, as there is not enough pressure reduction in manifold to provide a fuel flow.

The opening "M" of carburetor should be connected with breather pipe to crankcase to keep engine room free of gas vapor. The screen of air horn should be kept clean so that lint and dirt will not obstruct the flow of air into carburetor.

Carburetor

A drip pipe is located on bottom of carburetor to allow any surplus amount of gasoline to drip out of carburetor. A small pan covered with a very fine wire cloth should be placed under this to catch any drippage and keep it from running into the bilge where it would be dangerous in case of backfire. If gasoline continues to drip when engine is stopped, the float needle and gasoline level should be refitted to stop it. Flooding may be caused by a damaged float, a faulty seating of valve, gasoline level in carburetor too high, a damaged valve, binding of float or levers, too much pressure on gasoline line or dirt getting past strainers under valve seat.

Adjustments are made on carburetors during factory test and should be very close to the final adjustment needed. The high and intermediate speeds are controlled by the high speed adjustment needle, which controls the entire gasoline supply to the jet; screwing down or clockwise gives less gasoline, counter-clockwise more gasoline. When engine is warmed up for normal running, this high speed adjustment should be cut down to the minimum opening which will give steady running and maximum motor speed.

Beginning 1922 Models GR and GRS, 6 and 8 cylinder engines, with double carburetors have had air intakes coupled together to one main air intake. This greatly reduces unpleasant backfire from carburetor which may be due to lack of gasoline or inlet valve opening at wrong time.

Carburetor Adjustment

The low speed gasoline adjustment is controlled by the idling adjustment, which must be operated with a screw driver. This operates on air, so that screwing in or clockwise gives more gasoline and counter-clockwise, less gasoline.

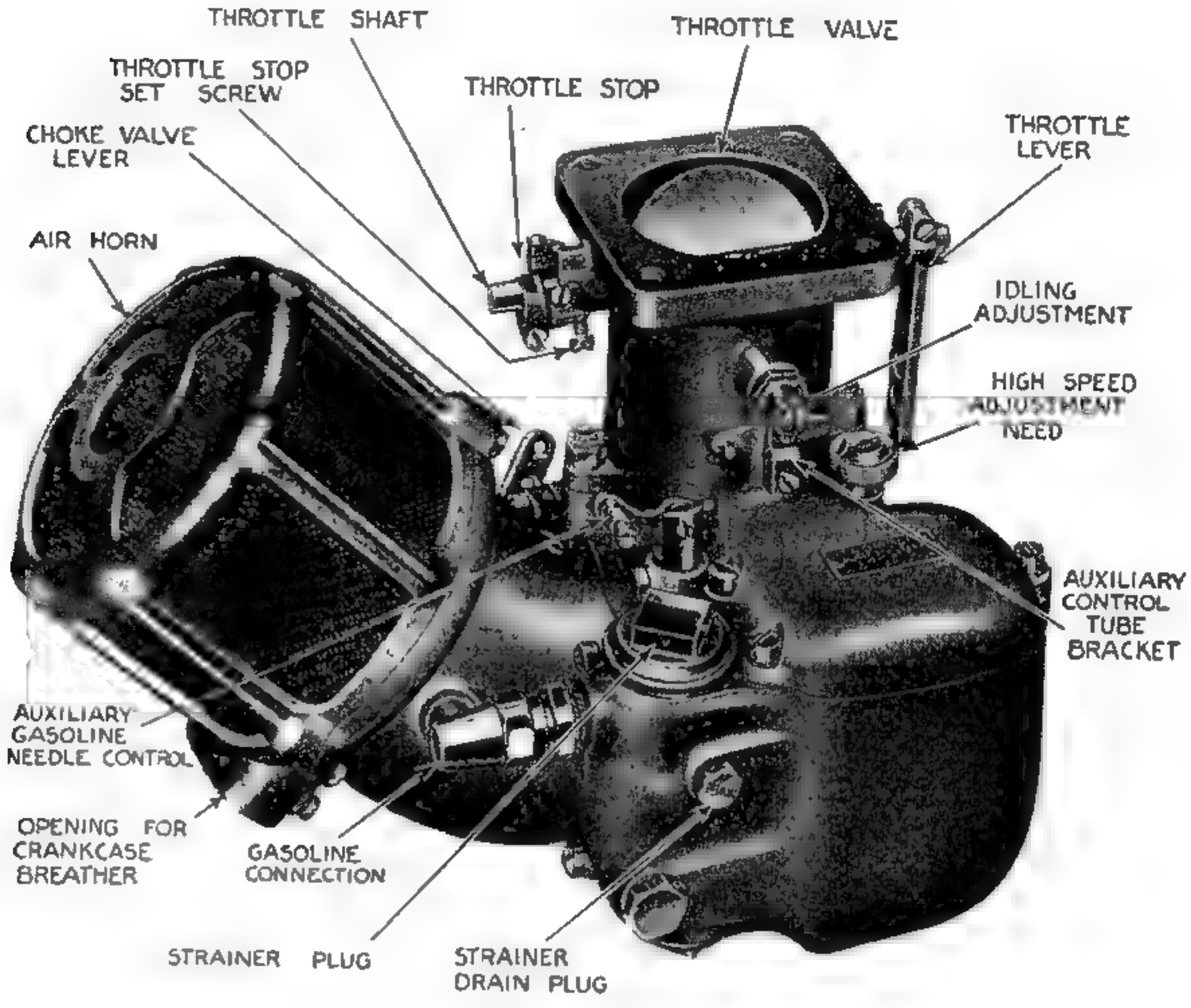


Figure No. 19

Stromberg Carburetor

Cleaning Strainer

A gauze strainer is located under the strainer plug to protect the float mechanism and fuel jets from dirt. This strainer should be cleaned every few weeks that the boat is in service. Removal of the drain plug will drain water and accumulated dirt from the strainer chamber and this should be done every fourth or fifth time the gasoline tank of boat is filled.

The choke valve is not used for starting, as the hand priming and opening of auxiliary needle control will supply sufficient fuel until engine is warmed up and running. Close the auxiliary fuel feed while running.

Strainers

A small strainer is located in the carburetor at gasoline connection, but it should not be necessary to clean this very often, if the main line strainer is drained every fourth or fifth time the tanks are filled. The gasoline from tank should have gasoline enter outside the strainer basket so that it does not become necessary to remove this and break the cover joint. Take out the plug under strainer after shutting off gasoline line valve, which should be between tank and strainer, and drain out strainer into some container. By opening valve momentarily, the strainer can be flushed out clean.

A gasoline strainer is furnished with the engine. This should be installed at engine end of full line, not at tank end.

Carburetors should always be connected to manifolds as originally fitted, with the throttle shaft running end to end of engine. Where governors are used, the butterfly throttle valve is removed and the hand control connected to the auxiliary valve.

Hand Primer

A hand primer pump is mounted on the engine manifold for injecting a fuel spray into manifold for starting. It is important to use this, as it insures prompt starting and avoids running down battery and flooding engine. On cruisers, we recommend that the engines be started from engine room and that the primer be left as mounted on engine. Four or five strokes of plunger should be sufficient to start an engine.

Piping

Annealed copper or brass tubing with compression joint fittings are recommended for all gasoline piping. Use $\frac{3}{8}$-in. tubing between carburetors and strainers and $\frac{1}{2}$-in. tubing from strainer to tanks. Use larger piping from tank when one line supplies two engines. Do not use iron pipe for gasoline. If piping is used, use brass pipe and solder all joints. A coil in tubing is recommended to prevent any vibration from effecting fitting joints.

A globe valve should be installed in gasoline line at both strainer and tank end of line. Gasoline connection should be made to top of tank and $\frac{1}{2}$-in. pipe run down from top to about $1\frac{1}{2}$-in. from bottom of tank where pressure or pump systems are used. Gravity flow tanks should have connection on bottom project up above bottom of tank 1-in. to allow settling basin for water or dirt. The tanks should be examined for accumulations of dirt or water several times a season and pumped or drained out. When steel tanks are used, these should be tin-coated inside and out to prevent rusting. When air pressure is used, the tank filler cap must be air tight, but on tanks for gravity or pump supply a small vent hole must be provided.

Air Pressure System for Gasoline Supply

A double acting plunger air pump on the port side of the crankcase near the timing gear end is driven from the camshaft by spiral gears. This pump draws air from the crankcase and is lubricated by the oil carried with the air. Discharge check valves are part of pump, but it is advisable to install another check valve at tank end of air line. Air line should be ¼-in. to 5-16-in. tubing. The pressure gauge connection is not made on the air line but on the gasoline line at carburetor, as the air line pressure would show on gauge, even if gasoline valves were shut off or line and strainers plugged. The main gasoline air pressure pump is arranged to maintain about three pounds, but can be increased to six pounds by reversing the caps at both ends. If the pressure is too great, open the pet cock in the end. Air pressure should not be put on square tanks.

Important

For starting pressure, it is necessary to pump up the tank pressure by hand, on account of the many different types of boats, this hand pump should be purchased as best adapted to the requirements. This pump is not part of our equipment. On a runabout, a small bulkhead pump 1½-in. to 2-in. diameter, with a stroke of 10-in. to 12-in., will prove sufficient for tanks up to 100 gallon capacity, but on cruisers with long tanks, a pump 4 in. in diameter with a 12 in. or 24 in. stroke is more suitable. The hand pump must have a discharge check valve.

EXHAUST PIPING

The full size of the exhaust should be maintained throughout the full length of the line, except when muffler is use it may be reduced slightly at the muffler outlet. Long bends are recommended. When sharp bends are made, special water jacketed brass elbow fittings are suggested. These can be obtained from the Sterling Engine Company, with a 90 degree or 55 degree from horizontal bends can be used according to conditions. The bends fit on either end of manifold and larger sizes suitable for GRS Models are made in the same styles. Pipe elbows make bends too short and are not as well adapted for tubing connections as the flanged elbow. Long bends can best be made by bending a short piece of the tubing and flanging it to the main exhaust tube.

Use exhaust piping of the following inside sizes:

	4 Cyl.	6 Cyl.	8 Cyl.
GRS	4-in.	4-in.	4-in.
GR and GRC	3-in.	3½-in.	4-in.
GM	3-in.	3-in.	3½-in.
GH	3-in.	3-in.	3½-in.

REVERSE GEAR AND CLUTCH

Reverse Gear and Clutch

The reverse gear and clutch is a combined unit with planetary gearing and a multiple disc. A single throw lever is used to operate clutch by throwing forward toward engine and by throwing back to operate reverse. The center of travel is the neutral or propeller idling point. The lubrication is supplied from the rear bearing through the crankshaft. Oil is returned to sump by the gear drum throwing it into troughs on the side of the housing, from where it drains forward. The tailshaft and propeller thrust bearing is lubricated by the splashed oil.

The clutch and reversing band should always be adjusted to prevent slipping. The slipping of the clutch is indicated by the speed of the engine increasing and the gear heating. Clutch adjustment is made through handhole opening on top of reverse gear housing. Turn engine until marking "Adjust Here" on drum lines up with mark on reverse band. (See Fig. 20.)

By releasing screw No. 890 about six turns, Nut No. 888 can be turned right handed forward until the screw will enter the next locking notch. One notch adjustment at any time should be sufficient for all ordinary wear of disc. Tighten screw No. 890 before starting engine. Lever locks in position when clutch is engaged.

Reverse band adjustment should be made so that band will be as free as possible and still hold the drum 787 from revolving when the engine is reversed. Slippage can be easily detected as the drum should remain stationary during reverse, so that clip 918B is free from notches. The screw 918 can then be turned righthand after releasing lock nut 918A. After adjusting, tighten locknut and replace clip and screws. The cam 828 should lock into reverse position and, if it does not, either the cam is worn and requires replacement or the band is adjusted too tight.

To remove reverse gear from the engine, take off housing by removing screws in flange and taking out pin 821 on top of control shaft lever. Tailshaft bearing dowel pins 869 must then be driven upward and screws 868 taken out. After taking out crankshaft coupling screws and reverse band screws, the reverse gear may be moved backward ¼-in. and lifted out.

ENGINE CONTROLS TO BULKHEAD OR BRIDGE DECK

Engines installed in runabouts are usually located with the reverse and clutch lever in the pilot's cockpit, where it can be easily operated. The spark and throttle levers can be connected to the control levers on the bulkhead or steering wheel. The engine controls are so constructed that connection can be easily made to them with suitable fittings and to facilitate connection, the levers can be placed in the most convenient position to connect with rods operating either fore and aft or vertical. Spark and throttle control rods and brackets must be fitted without lost motion and rods should be at least 5-16 in. in diameter and fitted with guide bearings when long enough to sag or buckle under compression.

Reverse lever connections on cruisers must be connected with not less and preferably a slightly greater leverage than that of the engine lever. This can be easily measured by comparing the operating handle travel with that of the hand grip on the engine reverse lever.

The strength and rigidity of all controls is important. The full movement of clutch and reverse lever must be obtained in order to obtain locking into position, otherwise the clutch or reverse will not hold. All joints must be free so not to bind either the clutch or reverse at the neutral point, otherwise the propeller will drag.

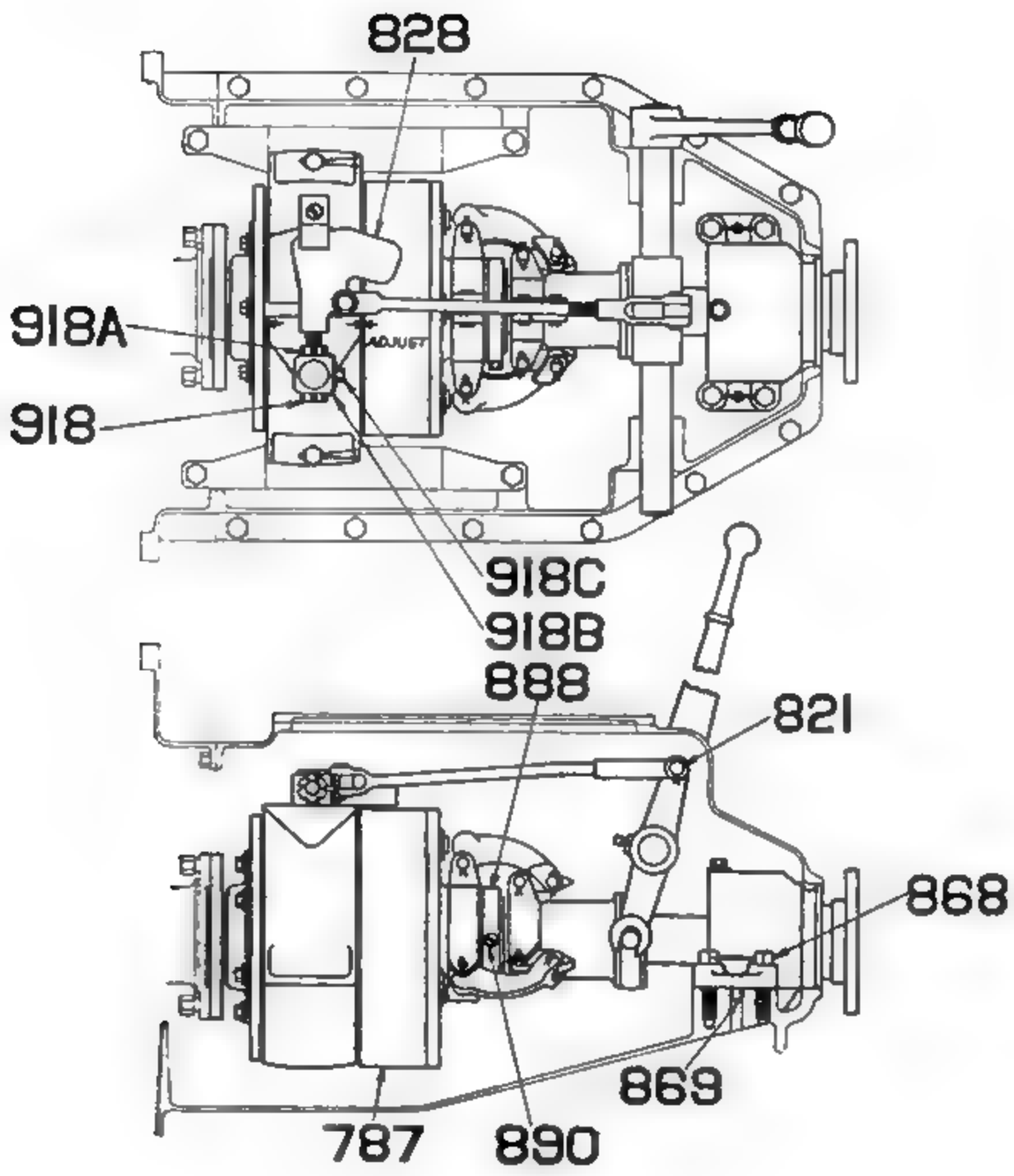


Fig. 20

Clutch Adjustment

ELECTRICAL SYSTEM

The electrical system consists of a starting motor—starting switch, battery, generator reverse current cut-out and ammeter operating on a 12 volt circuit. (See Fig. 21 for wiring diagram.)

The starting motor is a four pole straight series wound machine. A pinion or armature shaft meshes with the gear on a countershaft to obtain a speed reduction. On the shaft is a screw driving mechanism automatically meshing and disengaging a pinion with the flywheel when starting the motor. This mechanism requires little attention except that the spring should be inspected occasionally.

The generator is a bi-polar shunt wound machine with adjustable third brush output control. It cuts in or starts to charge at 650 r.p.m., and attains its maximum output at about 1200 R.P.M. The output is nearly constant at 7 to 9 amperes for about 1200 to 1500 r.p.m., but reduces again at higher speeds. Changes in output adjustment is seldom necessary as the driving speeds on the engine conform closely to those required to keep the battery properly charged.

On 4 cylinder engines running over 1200 r.p.m., the generator operates at engine speed on GM and GH 6 and 8 cylinder engines at 1½ times engine speed. Four cylinder engines running below 1200 r.p.m. and all GH models are fitted with geared boosting drives operating the generator at proper speeds to obtain the maximum output.

Electrical System

The generator field fuse is located accessibly at the commutator end of generator on top of the field ring. The fuse protects the generator if for any reason the voltage rises too high. If the generator fails to deliver current, examine the fuse and replace it. Loose connections or open circuits are the most common cause of trouble and all connections should be examined under such circumstances.

Retarded Spark

In any installation with ignition that is not entirely automatically controlled, care must invariably be exercised in starting to set the spark lever at full retard before cranking the engine. If this is neglected, backfiring with its accompanying severe strains on the starting mechanism will be almost certain to result.

Brushes

The starting motor brushes, like those of the generator, are of a particular grade, especially selected to suit the characteristics of the machine and should never be replaced by any except those furnished by the manufacturer of the instrument.

Starting Switch

The starting switch, which controls the starting motor circuit, consists principally of a pair of heavy contact blocks and a movable laminated contactor carried on a push rod. Both contacts and contactor are sufficiently heavy to give indefinitely long service under normal usage and accordingly require practically no attention in service.

This switch is used on boats where it can be located within three feet of battery and starter. A relay or magnetic switch is used if longer starter cables would be required. A small push button switch located conveniently is used to energize a coil. When the current flows through the coil, the magnetic field produced pulls an iron core to which is attached the main switch. This switch requires the same care as the hand operated type.

On runabouts installations, the relay switch is used but starting the engine by the operator is recommended on all cruisers. Consequently the manually operated switch is used.

Ammeter

The ammeter registers the flow of current from the generator to the battery and from the battery to the lamps. It is not, however, affected by current in the starting circuit and, therefore, does not register the starting current. Since the chief function of the instrument is to indicate the general performance of the electrical equipment, its readings should be watched fairly closely in order to detect the presence of trouble in case an irregularity of any sort should happen to develop. Abnormal readings of the ammeter should always be investigated promptly.

In the event of erratic readings, the meter itself should always be examined first before extending the investigation to the rest of the system because transposed connections at the indicator terminals or trouble in the instrument itself are the most frequent causes of abnormal behavior of the meter.

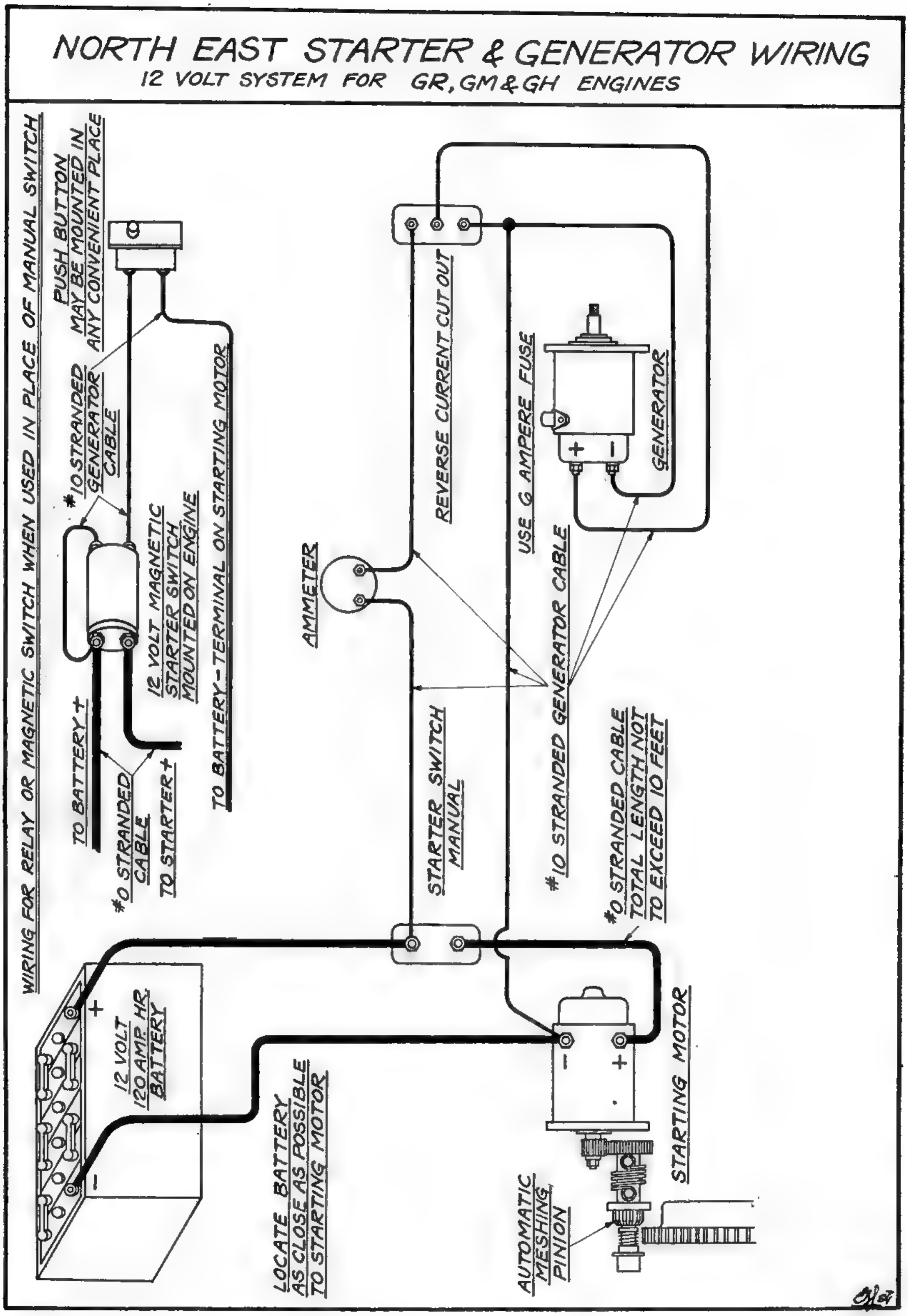


Figure No. 21.

IGNITION WIRING DIAGRAM

BATTERY

The battery serves as an auxiliary source of current for the electrical system when the generator is not driven at sufficient speed to enable it to produce current. Besides supplying the lamp current at such times, it also furnishes the current to the starting motor for cranking the engine.

The battery is ordinarily kept charged by the generator which delivers to it all its output not consumed elsewhere. In daylight running, the entire generator output goes to charge the battery, while in night running in boats, if lamps are used, when all the lamps are on, only a very small charge, if any, is received by it.

The battery should be kept full of distilled water and in a reasonably well charged condition at all times in order to enable it to perform its functions properly and also to keep it from deterioration.

At temperature lower than 25 degrees F above zero, the battery is liable to freeze if not kept in a well charged condition. Since a fully charged battery may, without danger, be exposed to temperatures as low as 40 degrees F. below zero, precautions should be taken during cold weather to keep the battery always properly charged. Where the equipment is not used during the winter months, the battery should be stored in a warm, dry place whenever practicable, and should be given a freshening charge regularly at least once a month to make up for the slow self-discharge that continuously takes place.

Keep cable connections on battery covered with grease or vaseline.

After 1922, batteries were shipped with engines without being charged.

See special pamphlet from battery manufacturer for instructions.

GENERAL OPERATING INFORMATION

Before starting engine when installed:

Make sure that engine base is clean and that no dirt has entered crankcase. Under no circumstances of installing is it necessary to remove handhole plates. Fill crankcase with fresh oil and supply tank with oil. Fill magneto and pump shaft bearings with engine oil and put light machine oil in generator, starter and magneto oil cups. Put the equivalent of three priming cups full of oil into each cylinder. Turn engine over several times before turning on gasoline, to work oil on cylinder walls. Prime oil pump with oil in plug in hole on front of pump.

Put spark plugs in cylinders. See that ignition and electrical system wiring connections are all properly and securely made.

Fill gasoline tanks, open valves and see that gasoline feeds to carburetor and that all connections are tight. To test lines when air pressure is used, it will be necessary to use hand air pump.

The engine can then be primed with hand pump on top of inlet manifold. Retard spark and throttle by moving levers backward; open throttle slightly; put ignition switch on dry cell battery position and lift auxiliary control lever in carburetor.

Be sure that clutch lever is in neutral and then press starter switch. Engine should start immediately. If it does not, locate trouble, as otherwise the engine would be flooded with raw gasoline, possibly scoring cylinders and the battery run down.

OPERATING ENGINE AFTER STARTING

As soon as engine starts:

Throw ignition switch to running battery position.

See that oil pressure shows on gauge.

See that oil supply pump is working.

See that ammeter shows generator charging.

See that gasoline pressure shows on gauge.

See that cooling water is flowing.

Throw clutch lever gently forward until propeller is in motion, then continue movement until lever locks. The throttle can then be opened further, but do not race engine nor run at full speed until propeller shaft bearings and all parts of installation are thoroughly examined to determine that everything is working properly.

To reverse:—Throttle the engine and throw clutch lever slowly into neutral and then into reverse. Do not throw back suddenly.

To Stop:—Slow down the engine, throw clutch into neutral. Throw off ignition, turn off gasoline, see that ammeter shows zero.

CAUTION

Do not race engine idle.
Do not run engine over half speed when new.
Do not forget to check engine speed when operating clutch and reverse in or out of neutral.
Do not run with clutch or reverse slipping.
Do not run with spark advanced too much.
If engine pounds, retard spark or locate trouble if from other cause.
Do not use waste, but use clean rags free from ravelings to clean inside of base.
Do not alter adjustments before starting, as the engine has been thoroughly tested before leaving factory and all adjustments made. Slight changes only may be found necessary after running. Do not attempt to make the adjustment alterations until each part is thoroughly understood.
NOTE:—For twin or triplex screw marine installations:
Do not run without having all engines running. If for any reason it is necessary to run without engine under power, throw the idle engine clutch in and open priming cups or remove spark plugs. Unless this is done, the clutch may be damaged, as it requires and receives lubrication from engine.
Do not run without full supply of oil in base and supply tank.
Do not use poor grade of oil. See recommendation under lubrication.
Be sure that oil pressure, oil supply, gasoline pressure, and generator output shows on gauges.
Be sure that water pump is working.
Do not run in weeds or sand without watching this and making sure that strainer is clear.
Always state engine number and model when ordering repair parts or seeking information. Describe fully the part or information desired.
When laying up the engine for the winter, slush crankshaft and pistons thoroughly with heavy oil. Slush all exposed steel parts, shafts, nuts, couplings, etc., to prevent rusting. Drain all water from cylinders, manifolds, pump and oil cooler. If water does not flow freely, open passage by inserting a wire into drain outlet.

ENGINE TROUBLES

CAUSE AND REMEDY

Failure to Start

1. Ignition Switch Off:	Turn on switch.
2. Starting Motor will not crank:	Take battery out if weak and have charged. Start by hand cranking, using dry cell for ignition. Retard spark when hand cranking.
3. Broken or interrupted electrical current:	See that wiring connections are tight and switches make contact. Switch may need cleaning. Wire insulation may be broken and current short circuited.
4. Foul or cracked spark plug:	Clean foul plug or replace broken one.
5. Insufficient gasoline:	(a) Refill tank. (b) Clean strainer of dirt or water. (c) Increase pressure. (d) Adjust carburetor to feed more gasoline.
6. Poor Compression:	(a) Can be determined by listening to blow past piston when turning by hand. All engines will blow somewhat, even in best of condition. (b) Be sure head gasket is tight. (c) Be sure valves all seat and that proper clearance exists. If valve has not been seating, it will be necessary to grind it in, as it may be burnt or warped. (d) If blow is past piston, rings may be worn and need replacemnt.

Engine Smokes at Exhaust

7. Oil:	(a) Oil may be too light. (b) Crankcase may carry too much oil and rods dip. If so, take out some oil. (c) Bearings may be worn and too much oil is thrown into cylinders.
8. Fuel Mixture:	(a) Carburetor may be flooding due to float sticking or too much pressure. (b) Adjustment may make mixture too rich.
9. Worn or Stuck Piston Rings:	(a) Worn rings will let oil past when idling or running throttled and this can be located as under starting trouble.

Irregular Action

10. Weak Explosions: Misfiring	(a) Gasoline mixture may be too lean. (b) Gasoline mixture may be too rich. (c) Valve may not be closing. (d) Lubrication may not be working or oil needs replacement. (e) Spark plugs may be dirty. (f) Dirty distributor or breaker points in magneto or distributor. (g) Water in gasoline. (h) Dirt in gasoline line.
11. Engine Racing:	(a) Clutch too loose and slipping.
12. Engine Knocks:	(a) Spark advanced too far. (b) Propeller too large. Engine should run about minimum rated speed. (c) Fuel rich and carburetor needs adjusting. (d) Bearings loose or worn and need refitting. (e) Carbon deposit in cylinders, must be cleaned out.
13. Hissing:	(a) Broken or loose spark plug. Replace or tighten. (b) Open or loose priming cup. (c) Loose cylinder head or damaged gasket. Use new gasket if tightening head does not stop. (d) Loose or damaged exhaust or inlet manifold gasket. Tighten or replace.
14. Engine Stops:	(a) Ignition may be off. (b) Broken wiring. Locate trouble and repair. (c) Magneto or distributor contact poor. (d) Weak battery. (e) No gasoline.

ACCESSORIES

Pump for air whistle is special equipment. The type supplied with the engine must be thrown in and disengaged by hand. It is not guaranteed for continuous operation and should only be used for whistle tanks occasionally when needed. See operating instructions on tag.

Bilge Pump is special equipment, supplied as an extra. It is not guaranteed for continuous operation and should be thrown in by hand when occasion requires and disengaged when through its duty. Grease cups should be kept supplied with lubricant and packing glands kept tight.

BUFFALO, N. Y.

STERLING ENGINE COMPANY

Built in 4-6-8 Cylinder Sizes

Models CRS—CR—CH—CM

Type "C" Engines

Operators' Instructions

S-1-33